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EDUCATIONAL RESEARCH

A Review for
Teachers and all concerned with
Progress in Education

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EDITORIAL

IN this issue of *Educational Research* we have made one slight departure from our declared formula of presenting the summarised results of research. The article by Dr. Dienes, which forms the third of the series on Arithmetic and Mathematics teaching is not, strictly speaking, a survey of a particular field. However, it seemed to us that the method he has developed, the material he has produced, and the experience already gained in its use represent a highly significant step forward in our thinking and practice in this subject, and that therefore no excuse is really necessary. Readers may find the first few pages somewhat difficult to follow—as, indeed, we did. The obscurity is not linguistic nor is it due to muddled or pretentious thinking (as is sometimes the case); the thought conveyed is in itself difficult but the attempt to master it is worth the pains since it is the key to what follows.

In this first issue of the academic year there is another small innovation. We publish an abstract from a thesis concerning a somewhat special group of handicapped children. In future issues and spread over the next few years, we hope to begin a series of articles, each one of which will be devoted to a broad category of pupils who need an education specially adapted to their needs. Papers will be devoted to the exceptionally gifted, to the backward and mentally subnormal as well as to those with mild or severe sensory or motor handicaps.

The topic of interests and their measurement is one of considerable importance to those who attempt to guide children between alternative courses at the secondary stage or who wish to help adolescents choose a career. As will be seen from the article on the subject, a great deal of work was done before the war and, sporadically, much has been done since, in this country, in continental Europe and in North America. In their article, Dr. Wiergesma and Mr. Barr try to bring some of it together in usable form. The article is of interest in another way since it represents a piece of practical collaboration between the N.F.E.R. and a Dutch organisation working in a similar field—and it shows how many common preoccupations there are in the two countries. We hope that future issues will continue to bear papers which result from international collaboration.

May we finally draw attention to the short article on Ability Grouping. This is a matter which, to judge by our correspondence, interests teachers from many points of view—in terms of the academic results of children taught in different kinds of class and terms of the educational effects of segregation. As with so many topics in education, opinions are the more hotly held in proportion to the absence of objective fact. Such firm knowledge as we have is set out in the article. The upshot is essentially negative, as it was concerning the size of classes. This, it must be emphasised is not due to a failure in research or to the absence of appropriate techniques. It is due to the smallness of the resources devoted to the study of the sciences of education. Objective information can be found; in conjunction with other activities, the N.F.E.R. will eventually get it: but unless finance and manpower are forthcoming, the time-lag will be considerable. We think that it is worthwhile, from time to time, to publish articles of this kind which expose the immense gaps in our knowledge of the most elementary matters; and we appreciate suggestions from our colleagues as to the topics which might be treated in a similar way.

THE TEACHER – PUPIL RELATIONSHIP

by K. M. Evans

(Lecturer and Research Officer, Faculty of Education, University College, Cardiff)

IN recent years there has been a shift of emphasis from the study of the individual to the study of groups and the behaviour and inter-relationships of the individuals who compose them. Techniques of observation and recording have been evolved and much interesting information has emerged concerning the structure of various types of group, leadership and isolation, and the effects of stresses and strains on group cohesion. The classroom group, being easily accessible and open to observation as some other groups are not, has come in for more than its fair share of study, and there is available a considerable amount of information both about teacher-pupil and pupil-pupil relations.

Teacher-pupil relations is a wide term, and studies of this relationship cover such topics as the influence of teachers on the immediate behaviour of their pupils and on their intellectual and social development, the contribution which teachers make to the mental health and adjustment of the children, the children's likes and dislikes with regard to their teachers, and the effects on the teachers of daily contact with their pupils. A small amount of the information available has resulted from definite observational studies of teachers and pupils in the classroom setting. More is to be found emerging incidentally from enquiries into other aspects of the teaching situation.

After its parents, a child's teacher is usually the most important and influential adult in its life, one who can exert an enormous influence on the child's character and mind. It has been suggested that where a child shows an educational difficulty, among the first things that should be investigated are the attitude of its teacher and the relationship between teacher and child. Education springs from the attitude of the teacher to his pupils, and the problem of the right attitude is central in teaching. The teacher must be able to include in his sphere of influence all types of children, the dull as well as the bright, the class hero and the outcast. At the same time the teacher must not regard the children as a means of satisfying his own desires and needs. They must be recognised as persons in their own right, so that the I-thou relationship is regarded as being of at least as much importance as the scholarship-intellectual relationship. The children have their part to play in their own education and must be seen as fellow-workers, not as so much material in the hand of the craftsman.

How much teachers can contribute to the adjustment of their pupils is shown in an account of an experiment in which twenty-three maladjusted children were left to the care of their teachers. The children were all of normal intelligence and achievement, so that they presented a psychological rather than an educational problem. Over a period of two years all except five improved considerably, the improvement being most marked in the case of the most intelligent children. The conclusion drawn is that, except in the case of children who are so severely maladjusted as to need specialist care, interested and sympathetic teachers can do much to ensure that their pupils achieve a satisfactory level of mental health. This calls for a depth of understanding which is part of the teacher's personality. It has been noted that social proficiency rather than intelligence is important here, and that the teacher who succeeds often does so because he or she pro-

vides what is lacking in the home. A deficiency in understanding on the part of the teacher may well have harmful effects. When a group of pupils who left school early were asked why they did so, the most common reasons given were discouragement and lack of interest, but ten per cent. mentioned specifically dislike of particular teachers who showed little sympathy with and understanding of their pupils.

At the same time, it must be remembered that teachers are human beings with needs of their own. Like other people, they need to be liked, and this sometimes leads insecure teachers to accept poor work and to try to impress their pupils with their knowledge. Teachers quickly form attitudes to their pupils and react favourably to those they find pleasing. The most successful teachers are usually secure and confident, they are interested in and like children, and are able to accept them. Sincerity is important here. Teachers may learn to disguise their feelings, but their pupils are usually aware of them. As one acute observer remarked, the personality of the teacher can best be studied by watching the reactions of the pupils.

The teacher's attitude of acceptance has been found to be closely related to his effectiveness as perceived by his pupils. The teacher who accepts himself and his environment as well as his pupils is likely to be effective in his work. It has been found that there is a strong tendency for teachers to prefer the pupils who are popular with other pupils, and to prefer least those who are least acceptable to their peers. This indicates that those characteristics of pupils which make for a poor pupil-pupil adjustment also tend to make for a poor teacher-pupil adjustment. At the same time there is evidence that teachers have, as a rule, little awareness of the true sociometric standing of their pupils. Where teachers have been asked to estimate the status of their pupils, the correlation between their estimates and the status as shown by a sociometric test has usually been low. Types of pupils who tend to be over-rated by their teachers include those who are outstanding in some way but unskilled in personal relationships, those who are courteous and responsive to their teachers but less pleasant to their fellow-pupils, and those who have desirable personality traits but are socially inhibited with their equals. Sometimes, too, teachers mistake for real liking the sympathy which children show to one of their number who is in some way handicapped. In one enquiry a crippled girl and a boy of another race, who appeared to their teachers to be very popular, were in fact found to be completely unchosen when the children indicated which companions they preferred for various activities. Pupils who can establish intimate relations with a few friends but who fail to respond in a large group, and those who antagonise the teacher but are liked by some of their equals tend to be under-rated by their teachers.

These findings, and also some which show that teachers are, on the whole, poor judges of the personality adjustment of their pupils, indicate that teachers are frequently unaware of the true basis of their reactions to their pupils. If the teacher-pupil relationship is to be therapeutic for those pupils who need this, the teachers must become consciously aware of the need. Otherwise it has been found that there is a strong tendency for them to overlook or misunderstand those pupils who most need their help. In view of the amount of good that can result for the pupils from contact with a teacher who is actively aware of their needs and desirous of helping them, there is a strong case for giving teachers all the available information about maladjusted pupils and for suggesting the

kind of treatment which would improve their adjustment. Almost all teachers have the interests of their pupils at heart and they are strategically placed to do far more for them in this respect than most other people.

Turning now from studies of pupils as seen by their teachers, we come to studies of teachers as seen by their pupils. An early study of those teacher-characteristics which pupils liked was made by Kratz in 1896. Since then there has been a steady trickle of such studies. Some of these deal with the opinions of children, others with those of college students, while some ask for retrospective judgments on the part of adults of their school or college teachers.

It is not to be expected that such different types of study will produce closely similar results. People of different ages have different needs, and accordingly require different things of their teachers. There is, however, a remarkable agreement among children about the qualities they like and dislike in their teachers. They like teachers who are kind, friendly, cheerful, patient, helpful, fair, have a sense of humour, show an understanding of children's problems, allow plenty of pupil activity and at the same time maintain order. They dislike teachers who use sarcasm and ridicule, are domineering and have favourites and punish to secure discipline, fail to provide for the needs of individual pupils, and have disagreeable personal peculiarities. The unanimity of the findings of these studies is sufficient indication that there is no need for further studies of this type.

Pupils' opinions of their teachers have been found to be very little changed by the passage of time. The impression once made seems to last into maturity, but exceptions occur where contact has been maintained after leaving school. Where there is a difference of judgment between adults and children it is nearly always because adults, remembering their childhood teachers, tend to think in terms of qualities which are generally desirable in human beings, whereas the children tend to think specifically in terms of their qualities as teachers.

There is also evidence that pupils and administrators tend to agree in their assessment of teachers. Both rate highly teachers who enjoy their work and who have close and friendly relations with their pupils. Agreement is strongest, as might be expected, in the case of the most and least effective teachers and differences of judgment are likely to be greatest in the middle group.

Among college students again there is close agreement on what qualities are most to be desired in their teachers. More stress is placed among these older and abler pupils on the teachers' knowledge of their subject matter and on their ability to teach it well. Looking back on their school teachers, a group of students thought that they had been influenced by them in many ways, morally, intellectually and socially, and by personal kindness, interest, encouragement and sympathy. The influence of the teacher seems to reach a peak during adolescence, girls feeling it at a slightly earlier age than boys.

Quite distinct from the work already discussed are observations made in the classroom of the behaviour of teachers and of the response it calls out from the pupils.

A well-known study in this field was carried out by Lippitt and White. Four groups of five ten-year-old boys took part in what are described as " club activities " under

different types of adult leadership, authoritarian, democratic, and laissez-faire. The authoritarian leader decided all the activities of the group himself, arranged the work of individuals, and remained aloof except when demonstrating. The democratic leader encouraged discussion of the task by the group, allowed a choice of methods and companions, and acted as far as possible as a member of the group without doing too much of the work himself. The laissez-faire leader left the group completely free; he provided materials but did not participate in any way unless asked for information. To eliminate the effect of the personalities of the leaders as far as possible, all groups worked for a period under each type of leadership and the leaders themselves changed their type of control when they moved from one group to another.

The reactions of the children to the different types of control were noted. Autocracy seemed to provoke two different types of reaction: submission, and aggression amounting to open rebellion. The democratic group was the most friendly and contented. The aggressive autocracy was the least contented. The laissez-faire group did least work. Pride in their work was most marked in the democratic group and least marked in the autocratic group. Since the groups were originally well-matched, these differences must be taken as caused by the treatments the groups received from their leaders.

In another set of studies made by a team of observers led by Anderson, two types of teacher behaviour were studied in ordinary classroom situations. These were described as dominative and integrative behaviour. Domination was " characterised by a rigidity or inflexibility of purpose, by an inability or unwillingness to admit the contribution of another's experience, desires, purposes or judgment in the determining of goals which concern others. In domination one attempts to make others behave according to one's own standards or purposes." Socially integrative behaviour, on the other hand, involved the pursuit of a common purpose and the reduction rather than the augmenting or inciting of conflict.

Although there were found to be differences in the proportions of these two kinds of behaviour displayed by different teachers, with most of them domination exceeded integration, particularly when the contacts were with groups of children rather than with individuals. The amount of domination increased during the afternoons and also as the term went on. Some children seemed to call forth more domination from their teachers than others, and boys did so more than girls. It was noted that children who tried to dominate others were in their turn met by domination from their teachers. Aggression was met by aggression and a vicious circle resulted.

Differences between their teachers were reflected in the children's behaviour. Those whose teachers were less dominative and more integrative were found to be superior in attention and co-operation and to show more spontaneity and initiative.

The question arose as to who initiated behaviour, the children or the teacher. The same children and the same teachers were studied again after an interval of a year, by which time the teachers had new classes and the children had new teachers. It was found that the behaviour of the teachers under the new conditions remained substantially the same, but that the original behaviour patterns of the children had given place to others which reflected the behaviour of their new teachers. There was little doubt in the minds

of the investigators that the children's behaviour was a response to that of their teachers, and not vice versa.

This is supported by other observations of the same kind. In particular, it has been noted that tenseness in the teacher results in a tense class, whereas a relaxed and unhurried teacher has a calm class. Where the teacher is careful and painstaking the class shows the same characteristics. In some cases it has been found that where the weaker teachers were not getting the responses they wanted from the children, they were instead getting responses which coincided with their own actual behaviour. These findings might profitably be pondered by all teachers, for from time to time we are all puzzled by the apparent lack of co-operation which our best efforts call forth from our pupils.

Pupil-teacher relationships are the result of many influneces besides the actual personality qualities of teacher and pupil. The pupil's attitude to adults and to authority is conditioned by his home environment and by what happens to him outside school. The approach of both pupil and teacher may well be affected by what has happened to them in other classrooms or other schools. The subject matter of the lesson, too, plays its part. Given goodwill on both sides, a harmonious relationship will almost certainly result. Where the relationship is not harmonious, a teacher who sincerely desires the welfare of his pupils may easily be baffled to account for the pupils' attitudes. It is quite possible that the chief defects leading to a bad relationship may lie in the pupil, but the teacher who is concerned to improve the situation and has faith in himself and the children is in a strong position to effect an eventual improvement. The children are immature, and the teacher, whose maturity can give them a sense of security, is the person who determines the ultimate pattern of classroom relationships.

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The Teaching of Mathematics—III.

THE GROWTH OF MATHEMATICAL CONCEPTS IN CHILDREN THROUGH EXPERIENCE

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I. Introduction

THE purpose of this article is to show that there are ways in which mathematical concepts can be caused to develop in children so that the techniques they learn are preceded by an understanding of the corresponding mathematical structures.

There have been a number of attempts in recent years to do this, notably those of Cuisenaire and Stern. However, without minimising the importance of these initiatives, we hope to show that a great deal remains to be done, if insightful mathematics learning is to be achieved throughout children's mathematical careers. The full development of some of the more difficult concepts means that some experiences must be assimilated perhaps several years before the concepts are actually formed. It follows too that whereas a variety of experiences may be suitable for forming an early concept, only some of them will be fully suitable as preliminary experiences for later concepts. A full course of mathematical experiences, therefore, must be planned, both according to a carefully thought-out mathematical progression, and according to a definite theory of concept formation in children.

The mathematical progression chosen will, to some extent, depend on our theory of mathematics, as well as on how mathematical experiences can be dove-tailed to our theory. Here we may remark that it is perhaps not generally realised by teachers that different and opposing theories of mathematics are held by professional mathematicians themselves and that to such differences may well correspond differences in the ways in which children understand mathematics. We have, therefore, to allow for such differences in children and in mathematical theory so as to minimise their effect on learning. This means practically that the learning experiences we give should be varied enough to allow children to form their own concepts in their own way, instead, as we now tend to do, of trying to teach them in ours.

2. Aspects of thinking

Even to a casual observer it is clear that different people think differently. If they did not, there would never be any arguments and there would be no problems of communication and of understanding. We are not here particularly concerned with how these differences arise, whether they are innate or acquired, but only with the fact that they exist. Recent research by the writer has been able to throw some light on the

nature of these differences (Dienes, 1959), but much remains to be done. We know, for example, that some people must formulate their concepts very explicitely and exactly before they can use them, while others can think in terms of the same concepts with equal efficiency but with only a small amount of such explicit formulation. Or again, some people, as Bartlett points out, tend to think of broad concepts in terms of the internal relationships of the constituent concepts, while yet others build up their concepts following some intuitively-realised requirement or standard. For the former it is more the detail and its intricacies, for the latter more the overall picture, that counts. These might be called the *analytical* and the *constructive* aspects respectively.

This distinction between analytical and constructive thinking is fundamental to the understanding of what follows. We may, therefore, here give some examples from ordinary mathematical thinking to show just what is implied. Take the statement:

$$\tfrac{1}{3} = \tfrac{2}{6}$$

This can be considered as expressing a relationship between the numbers 1, 3, 2 and 6, the relationship being embodied in the symbols used. It is the relationship of ratio. This is derived from a great number of such sets of numbers such as, e.g. 3, 4, 9, 12.

This would be the analytical aspect of the concept. But there is an entirely different way of looking at the relationship, namely, we can look at it as a build-up. In this case the relationship is not even seen, or only very dimly seen. In this conception the whole would be considered as consisting of six objects, which are seen as made up of three equal parts or thirds, and at the same time these thirds are seen to be made up of two objects. Mathematically, there is, of course, no difference between these two ways of conceptualising the statement $\frac{1}{3}=\frac{2}{6}$; but the personal emphasis can be on one side or on the other. Another example from an earlier stage would be the difference between " take the next number " and " add 1 to the number." The relationship of " nextness " is the analytical counterpart here of the constructive " add 1." In both cases, mathematically, we are dealing with obtaining $n + 1$ from n, but again the emphasis may be on the analytical or on the constructive side.

It would be possible to pursue this kind of analysis and to suggest other ways of thinking about similar or different mathematical statements. To prove their existence and interrelationships would involve a long and careful series of experiments. We are not, however, going to pursue this course here, but will restrict our considerations to the analytical and the constructive aspects. It is not suggested that these are the only forms of thinking invoked nor that they are mutually exclusive; however, they are important and we may assume that different people approach the same problem attaching varying weights to these different aspects.

Apart from differences of individual emphasis of the above kind, we must consider the possibility that there are ways which are objectively better or more efficient for acquiring a given concept—that is, that a weighting in favour of one aspect may be objectively better because of the inherent nature of the concepts in question. It has, in fact, been shown that certain concepts are just not amenable to learning by certain forms of mental organisation; objective methods are now being developed by means of which such regions of optimum emphasis may be determined. [Dienes, 1957.]

Consider now the problem of the teacher and the pupil. Each of these two will have his own region of emphasis, and these will have to overlap with the region of optimum emphasis as well as with each other if insightful learning is to take place (*see diagram, figure* 1).

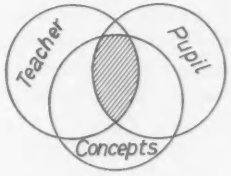


Fig 1

The boundaries to these regions will remain elastic if the teaching is varied and non-dogmatic, and an overlap can be secured more easily. If, however, we increase the number of pupils, it seems likely that we decrease the chances of a common overlap in all the regions. If there is no overlap between the regions of emphasis of the pupil and the teacher the pupil will not follow the teacher, since understanding is a mutual dove-tailing of the different aspects called into play. Without understanding, only rote learning can ensue—followed very often by dislike of the learning situation. This, alas, is what seems to happen in many mathematics lessons; the majority learn by rote and dislike the lesson. Our explanation would be that the required overlap can only be achieved in a few cases. These will become the pupils who are " good at mathematics." It also goes some way to explain why some children, who have made little or no progress with one teacher, will make a surprising leap forward when they come into the care of another.

If we accept the above explanation, it seems open to doubt whether what we have so far understood by " mathematical ability " is anything directly innate at all. Differences in mathematical attainment will therefore be explained by inherent (i.e. genetic) differences in general learning ability, and by whether the environment has or has not presented the child with mathematical experiences and teaching suitable to his way of conceptualisation. It follows from this that if we could make truly appropriate experiences available to a larger number of pupils, we should rear more mathematicians. The immediate task would, then, appear to be to increase mathematical insights in the classroom, but early enough to prevent the dislike which is the consequence of too many unsuccessful efforts at insight.

In planning the generation of such a succession of insights it is important to note that the constructive aspect of thinking develops much sooner than the analytic one. Children's early concepts are much more constructively than analytically directed. Piaget's famous examples on conservation of quantity (e.g. children under six or seven tend to think that if you scatter a group of objects more widely, there are more of them) suggest that the overall visual picture is, at this age, a much more powerful determinant of a concept than are the corresponding percepts of its analytical aspects. Notions of quantity at an early stage are linked with what a group of objects *looks* like, not with exactly how many objects there are in it. Piaget goes on to state that although children

acquire, fairly early, reversible number concepts which are detached from sensory impressions, they are not really capable of abstract thought until the age of 11 or 12. Clearly, for abstract thinking we must here read analytical thinking. Piaget admits only analytical thinking as being abstract, and that is, no doubt, the consequence of his formalistic view of mathematics which bases it on logic. An intuitionist mathematician, i.e. one who regards the number series as fundamental and logic as secondary, would consider the overall type of thinking as being just as abstract, perhaps more so. As we shall see, the constructive aspects of many concepts can be developed long before the age of 11; these aspects pave the way for the later and fuller analytical understanding.

Let us illustrate the point by a further example. Take the multiplication concept. Take the two blocks illustrated below, one in each hand, and ask a six-year-old child: " The long one is how many times as big as the small one? "

Fig 2.

A great many times the answer will be 3 not 4. This is because the child cannot yet appreciate the relationship 1 : 4 between the two objects (analytical thinking), but starts with the small object and mentally builds 3 more of them to make the long one (constructive thinking). Such a child needs a lot more practice in making the long piece with the little pieces. It is only through such practice that he can be led on to analytical thinking, constructive exercises having to precede the analytical insight. It may be that some children will never reach the analytical stage; the great challenge to the teacher is that of devising ways and means of making the whole of mathematics available to such children.

A further example is the concept of area. This concept involves multiplication (already quite difficult), as well as the concepts of linearity and superficiality. Children repeat the phrase " Length times width equals area," but they cannot see how inches are suddenly turned into square inches as though by magic, by a mere multiplication. Suddenly, the lengths have become an area, whereas just now they were just lengths. If one allows them to build a rectangle out of, say, 24 little squares, they will soon see that. for example, there are 6 rows of 4 or 4 rows of 6. It does not need many such exercises before they realise that the number of rows by the number in each row gives the total number of squares. This is the constructive aspect of area and usually if we stop at this point there is no trouble. What the non-analytical child cannot do is to identify the number of rows with the width, and the number in each row with the length, say. This insight may have to wait its turn, and will only occur when the child is ready for it. No amount of " explanation " will help. What seems to be reasonably probable is that it will never occur at all as an insight without the necessary experience and the child will repeat the formula like a parrot.

If we accept this analysis of the learning situation in a classroom as essentially a problem of creating a common overlap of " way of thinking," it is hard not to conclude that concepts cannot be taught at all successfully. The fact seems to be, that truly mathematical concepts are grasped only by a minority of children and this seems to bear out such a conclusion. However, it does not follow, of course, that concepts cannot be learnt, even though conventional teaching fails to ensure this. If research now in progress on the problem of finding the individual differences in thinking is fully successful, it may enable us to put children into groups homogeneous as to " thinking habit ' and thereby make effective teaching possible.

In the meantime, however, other methods must be found to enable insight to occur efficiently and more or less spontaneously by allowing children to work through many structured experiences. It is reasonable to hope that with carefully devised material providing a variety of experiences of different kinds we can create a situation in which children will abstract their own concepts in ways that suit them best. The overlap problem between teacher and pupil can thus be largely circumvented. We are then left with the problem of securing an overlap between pupil and concept structure. To cope with the latter is, of course, the essence of the learning problem. To understand the concept means just the dove-tailing of the individual emphasis of approach to the objectively optimum emphasis, and this is just what we mean by creating an overlap.

3. The dynamics of concept formation

It is time, therefore, to turn from the static picture of a concept to examine the dynamic problem of how such a concept arises. We shall borrow from Piaget's observations.

According to him there is a first, rather unconscious, " play " stage. In this stage, activity appears purposeless and undirected. Such is, for example the baby's first play with separate objects. He does not realise that he is laying the foundations of the concept of natural number, although his play is quite indispensable for the later acquisition ot such a concept. In an entirely fluid and objectless world, it is hard to imagine that the concept of natural number could arise; concepts such as flow would be more fundamental. In the second stage it is vaguely realised that something needs to be attained, and a certain amount of direction begins to creep into the " play." In our example, objects are grouped into classes, compared, even " counted," although the number words at this stage are no more than tools with which to play a verbal game. The third stage begins with a rush of insight or realisation, the constituent parts of the concept suddenly click into place. A child might say: " Look, there are five here and there are five there! It's just the same!" This is usually followed by a great number of repetitions and a desire to " practice " the newly-found concept. Thus, the concept becomes part of the person, becomes truly operational, and is used for everyday categorising for ever more.

Let us look at this process more closely. In the first stage, behaviour has no apparent directionality. It seems haphazard, purposeless, and so appears playful. As this stage merges into the second stage, the amount of directionality increases, more purpose comes into the behaviour. A goal is being sought, without a realisation of what the goal is.

The existence of explicit labels, such as words and other symbols in current use, must also have a profound effect on the direction and acceleration of this stage. In other words the " culture " will influence this stage to a very large extent. We shall see that this is the stage which has the greatest educational opportunities as well as the most serious pitfalls. After sufficient information has been accumulated out of these experiences, this crystallizes into a form of organisation. This is what we call an insight. It may be a more or less explicit insight, a more or less constructive or a more or less analytical insight. As we have seen, there is reason to believe that individuals vary greatly in such structuring of their experience. Having achieved the insight, they will be ready to practise it, i.e. to find " feed-backs " into fresh experience. It is in this way that an insight, all new just now, soon becomes concrete enough to be used as an object of play and can start a new cycle. We shall call these the " Piaget cycles."

Some examples will make the matter clearer. Take the concept of *square*. Children from a very early age make patterns with like objects such as counters, pegs, etc. Such pattern building generally tends to be symmetrical and squares are bound to be constructed. This tendency is reinforced by the sight of an overwhelming number of squares and rectangles which abound in our culture. These activities would form the first stage. The child is quite unaware that his experiences will lead him to some as yet unconceived concept. These preliminary experiences are also partly preparatory to such concepts as *right angle*, *straight line*, etc., although these will need further and different first-stage experiences as well. Eventually, questions about shape, length and width, and possibly even about number of rows and number in each row (in the more analytically minded) will occur to children. They are at this stage becoming aware that there is something to discover about squares and some may even ask: what is it that makes a square a square? When this question is answered, if only implicitly, then the individual form of the child's concept of a square will have begun to take shape.

In the normal unhindered process of concept forming, no Piaget cycle begins until all its parts are ready as play objects from some previous cycle, so that the new cycle can be started. The moment " teaching " interferes with this natural process, there is a danger of attempting such cycles before the child is ready. All previous necessary cycles may not have been completed and the situation may not be mature for the next. To begin a cycle before the child is ready will probably lead to a failure to complete the cycle. Only the outward signs will be assimilated (e.g. formulae on the board), and so only rote learning will occur. The dynamic equilibrium of concept formation is delicate and easily upset by interference, emotional or intellectual; we hope to show, on the other hand, that if the teacher is aware of the stage through which the pupil is passing, he can considerably help the learning process. To do this he must provide appropriate experiences or hints, at times when these are beneficial and not harmful to the completion of the cycle in progress.

To help solve this problem, we propose to distinguish carefully three different types of experience. In this article we shall call these experiences games. They are as follows: (*a*) preliminary games; (*b*) structured games; (*c*) practice games.

A game is classified in relation to a certain concept. The same game can be a practice game for one concept and a preliminary game for another.

A preliminary game corresponds to Piaget's first stage. In relation to the concept in question it has little or no structure, it has the haphazard appearance of play.

A structured game has a certain directionality built into it. This directionality corresponds to the structure of the concepts whose formation it is intended to precede. If this direction is not picked up by the subject, he needs more preliminary games or games differently structured. If it is picked up, i.e. if he does what he is " meant " to do with the material, he will be working towards an insight. When the insight occurs, he is ready for the next stage.

The next stage is the one of practice games, whose role it is to help anchor the new insight firmly into the child's experience. These may also act as preliminary games for later concepts.

Let us again give some examples to make it clear what is meant by the three types of game. Consider the Theorem of Moments. In its simplest form this states that if two weights W and w are in equilibrium on a balance at distances a and b from the fulchrum, then

$$a \times W = b \times w$$

The immediate component concepts are: length, weight, equality, rotation, multiplication, apart from others on which these are based. Let us assume that all these concepts are already fully operational, i.e. that they can be used as play objects for starting a new cycle. This is clearly not yet enough for an insight into the Moment Theorem, even into the elementary form in which we have stated it. Experiences such as a form tipping up when you sit on one end of it, the efficient working of a see-saw, levering heavy objects, etc., are further necessary experiences. These would be, in this case, the preliminary games. Some of these games may be played before the other component concepts have been formed, and be spread over a period of years. Now games can be devised using a balance with hooks at equal intervals from the fulcrum on which metal rings can be hung. At first there will only be random play. The child will hang rings on the hooks producing inequalities, i.e. disequilibrium. Soon, however, the structure of the material will induce the child to ask certain questions, to which experience with the balance will provide the answers. Suggestions may accelerate this structuring, and eventually the conditions of equilibrium will be found. Thus, a structured game leads to the eventual insight. Now problems can be asked about the balance (e.g. how many rings on the second hook will balance 2 rings on the third hook?), which will act as practice games, but also as preliminary games to further concepts such as equations; more preliminary games involving finding a number should be followed by the intensification of the structuring in that direction, if this is the aim in view. This in turn will lead to further insights and the cycles will follow one another, much as in the natural case.

It cannot be over-emphasized that the games must be played at the times which are appropriate for each child, otherwise confusion and even boredom will arise. Some so-called " activity " methods have failed often because practice games have been used where preliminary or structured games would have been more appropriate. Examples

of this, unfortunately, abound in our Infants Schools, as the reader will find no difficulty in seeing, if he agrees with the foregoing analysis.

In the natural concept formation process which goes on uninterruptedly all the time, artificially structured games are rarely played, and if they are, the structure itself is supposed to provide the amusement, as in a game of chess. Nevertheless, experiences have their own structures, and so some experiences will tend to lead towards a concept more quickly than others. The " play " quality of these early experiences is probably a powerful stimulus towards the attainment of concepts, and a careful selection of these play experiences could accelerate such growth considerably. Such selection is essentially the task of an Infants teacher. Unfortunately, these natural situations and games do not take us all the way. Although clearly as many of the games as possible should come from the children's real life situations, there comes a time when this is impossible. As higher and higher order concepts are aimed at, the number of life situations that could usefully lead up to them diminishes. Eventually, we are faced with having to teach children concepts for which they have absolutely no background of experience at all. What life situation is analogous to the complex arithmetical process of multiplying 27 by 45? The structure of the task is so special that no everyday experience corresponds to it. Clearly, if we still wish the child to form concepts as a result of experience, then we must provide him with artificial experiences to lead up to these more complex concepts and processes. In other words, there is a serious gap in a number of fundamental cycles, and it is the specifically educational task to fill in these gaps. It is taken for granted that experience must precede the concepts of Physics and of Chemistry. To drive home the relationship between pressure and boiling point, water is made to boil at low temperatures. Such experiences are essential for the understanding of the physical relationships involved. It is a curious fact that in the much more difficult case of mathematical relationships, such experience has not been regarded as necessary.

If, on the other hand, we are agreed on the necessity of providing such experiences to help mathematical learning, then we are faced with the task of constructing a series of pre-conceptual experiences which will fit into the children's natural concept formation cycles and will generate the required insights in at least the majority of cases. Since so very little has been done in this direction, there is very little to go by, except plausible hypotheses which may have a priori face validity. We shall now discuss a number of such hypotheses.

Hypothesis A. Visual, tactile and muscular images must be formed to create perceptual equivalents of a concept. From the common essence of these will be abstracted the conceptual structure.

This suggests that the more varied the perceptual models, the easier the acquisition of the concept. It is when we have had dealings with a variety of perceptual equivalents of a concept that we discover the purely conceptual structure by seeing that there is something in common to all the perceptual equivalents. It is thus that a really mathematical insight is achieved. A visual aid, or any other single " aid," although no doubt better than no aid, merely links the symbolism of mathematics to a visual equivalent. The " picture " of the concept is not the concept itself. The picture of 25 pegs arranged

in 5 rows of 5 is no more the mathematical idea of " square " than is the symbol 5^2. It is the realisation of the common properties of a great many different such representations that constitutes the mathematical insight. We must pass from the percept to the concept, this being the process of abstraction.

Hypothesis B. The higher the level of generality at which a concept is formed, the wider its fields of possible applications.

We mean that the more we learn an idea as " that kind of thing " rather than " that thing," the wider will be the field in which we can apply it. In an experiment with rats, Bruner found that some of those rats that had learnt an alternating right-left maze, learnt an alternating black-white maze more quickly than others that had had no such experience. It seems that some of the first lot of rats had acquired at least an inkling of the more general concept of alternation, of which both left-right as well as black-white are particular cases. These rats applied this general concept to a wider field. The rats that did not make any transfer, learnt the left-right maze as left-right, and had no operational grasp of the " kind of thing " a left-right was.

Hypothesis C. A concept involving variables is best understood in its full generality if the variables contained in it are made to vary.

If we wish to teach the concept of a rectangle, we clearly cannot do it with a collection of congruent rectangles. We shall need to vary the sizes, shapes and positions of these, in order to convey the concept in its full generality. Thus, the concept will be deprived of all trimmings that do not form an essential part of it, and the general structure " rectangle " will be learnt.

Another example would be a moving object among some still ones. The eye will obviously alight on the moving object and follow it, in preference to the still ones. The hypothesis states that a conceptually moving object, i.e. a variable that is made to vary, is more readily followed in its generality, than a conceptually still object, i.e. a constant.

We shall see later on how apparatus can be devised in accordance with the above three hypotheses.

5. Classification of concepts

It is essential to have at least a rough classification of the concepts to be considered in terms of their mathematical content. We shall distinguish three types of concept:

(*a*) pure mathematical concepts,
(*b*) notational concepts,
(*c*) applied concepts.

The *pure mathematical concepts* are those that deal with number alone, or with relationships between numbers, and are independent of the ways in which we express numbers.

The *notational concepts* are those that deal with those properties of numbers that arise as a direct consequence of the ways in which we express numbers.

The *applied concepts* are those which express different facets of the real world as we find it by means of already formed mathematical concepts.

Pure concepts are, for example, the following: that 9 objects can always be arranged in as many rows as there are objects in a row, that there are some numbers for which this is possible and others for which it is not, that 12 can be regarded as 3 times 4 or 4 times 3. All these are quite independent of the notation used. We can write the corresponding numbers in our usual notation, in Roman numerals, or just by using dots on a sheet of paper and these properties would not be altered. They express properties of numbers as numbers and not properties of the way we express numbers.

Notational concepts are, for example, the following: that IX in Roman notation denotes I less than X, that XV denotes V more than X; that in 32 the first digit really means 3 tens, and the second 2 units; that when you add 27 to 38, having grouped the numbers in groups of 10 and whatever is left, you re-group the 15 into a group of 10 and 5 odd ones and join up all the groups of 10. The concepts mentioned are notational, because they would disappear if we changed the notation. There are, however, some pure concepts at the basis of the notational concepts mentioned. For example, the concept of grouping in certain size groups, and the concept of adding, are pure concepts. The concepts of grouping in tens with the accompanying convention of place value, of addition within our number system, are notational. Clearly, the pure concept must come before the notational concept, the latter being based on the former.

Applied concepts are, for example, the following: length, area, volume, weight, time, money-value, etc. When we speak of the length of a table, we consider one facet of the reality of the table as relevant, we purposely disregard all the others, such as its shape, height, colour, weight, etc. When we want to remove a table to another room, then facets such as the combinations of certain dimensions as well as weight, immediately become relevant. An applied concept is the consideration of one particular facet of reality while all others are temporarily ignored.

We cannot here discuss the full sequence of mathematical experiences which we might think should form the basis of our children's mathematical education. We shall take some examples of each of the above types of concept and show how, by using appropriate material, the necessary insights can be generated.

6. Pure concepts

In order to make clear what is meant by the development of a pure mathematical concept, some examples will be given, with suggestions as to the kind of material that might prove useful. The material now in use in a number of Junior Schools and in some Secondary Schools consists of a large number of inch squares, a smaller number of larger squares and rectangles, a number of strips an inch wide and 5½in. or 7½in. long; a large number of inch equilateral triangles, a smaller number of 2in., 3in., 4in., 5in. and 6in. triangles, all equilateral. There is also a pegboard with a large number of pegs, and a balance with hooks as already described on page 15, with metal rings. Children work with this material in pairs or singly if they prefer it. Each child has access to sufficient material to enable him to be handling it individually. No demonstrations are conducted

by the teacher and the pupils work from a system of instruction cards. There are periodic diagnostic tests; records are kept of each child's concept attainment as he works through the cards; and revision cards are provided where needed. The reader should try to picture a class of 30 to 40 children, possibly actively engaged in as many different enquiries, guided by the cards and the supervising teacher.

Let us now consider an example and again take the mathematical concept of square. Children are asked to build larger squares out of a certain number of inch squares. They will note the numbers of smaller squares with which it is possible to do this, and others with which it is not. If it is not, they are encouraged to find how many more are required before they can complete the " next " square. Then follows the same problem on the pegboard, with pegs instead of squares. Then might follow the problem of making bigger triangles out of the inch triangles. They can be asked to make " diamonds " by putting two triangles together, and again find how many of these would make a bigger diamond. The same problem can be asked with the trapezium. If the children record their findings they will soon see that they always obtain the same numbers. These numbers have some sort of " magic " property, and it is the closer realization of this " magic " which is the process of abstraction leading eventually to the mathematical, not geometrical, idea of square.

The mathematical concept of square is an important connecting link between the measure of length and the measure of area. The games described certainly act as preliminary games to this link and as structured games to the more immediate concept of mathematical square. Hypothesis A is clearly being invoked, by giving the children many perceptual equivalents from which they will abstract the final concept. The variability of the sizes is in line with Hypothesis C as far as the immediate square concept is concerned; the variability of the shapes establishes experiences towards the final linkage of length and area in the much later similar figures theorem. It is impossible to test Hypothesis B, as we have really no other way of testing the generality of a concept except by the width of its applications by the subject. Therefore, this hypothesis is bound to remain a theoretical construct, and can only be tested in practice in conjunction with Hypothesis C.

The concept of square can be further evolved by leading on towards the relationship $(a + b)^2 = a^2 + 2ab + b^2$. This is probably best done at first by varying b and keeping a constant although a certain amount of variation of both is ultimately essential. The latter can be done by splitting say a 7 by 7 square of pegs into a 4 by 4, two 4 by 3 rectangles, and a 3 by 3, and repeating this with different size squares and with different splits. The former can be done by one square (say $5\frac{1}{2}$ by $5\frac{1}{2}$), any even number of $5\frac{1}{2}$in. strips and the necessary number of inch squares to complete the geometrical square. Here $2b$ is, of course, the number of strips, and b^2 the number of inch squares. According to Hypothesis A this is not enough, so we call in the pegs as a further equivalent, in this

case keeping one square constant, which determines the length of the rows of pegs (again $2b$ rows will be necessary, each consisting of a pegs).

But probably the most powerful tool for detaching the growing concept from the geometrical square equivalent is to do the same task with triangles. The pupils should arrive at the conclusion that if we put a triangles along the side of a big triangle (see figure 3), then a^2 triangles will cover the big triangle. Such a set of triangles fitting a large

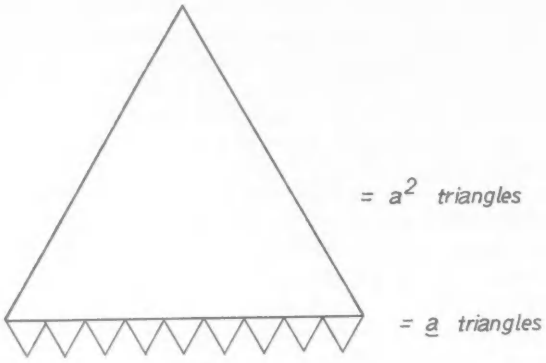


Fig 3.

triangle can be called a row. The length of a row depends on the size of the triangle chosen. It is now suggested that another row should be put on to the existing pieces. Almost invariably the " gaps " between the " spikes " are filled in, sometimes a hint is necessary to count the number of triangles in the second row. It is then clear that 1 triangle is missing from the " next " row. This is a highly structured game in the direction $(a + 1)^2 = a^2 + 2a + 1$. It is then tried with 4 rows, 6 rows, etc., and the number of triangles missing each time will, of course, be the magic numbers. Another step has been taken towards the formula for $(a + b)^2$.

It will be seen that nearly all the games are constructive. But when the situation is ripe, the game can be turned round into its analytical aspect and problems such as the following may be asked: given 49 inch triangles, make out of these (*i*) one large triangle, (*ii*) 6 rows, (*iii*) 9 odd inch triangles. How long must a row be? This is structuring the experience in the direction of quadratic equations. Of course, the same question can, and in most cases should, be asked about pegs and about squares.

It will be seen that quite high order concepts can in this way be made available to younger and less intelligent children than has been possible by conventional methods. The constructive leading will not harm the analytically-minded child, as he will automatically discard the apparatus as soon as he has analysed the structure of the task.

It is suggested that the pure concepts, leading naturally to algebraic relationships, should be encouraged to develop side by side with the arithmetical concepts. The latter would, of course, be chiefly the notational concepts involved in our system of writing numbers. The pure concepts are really necessary before the notational concepts are established. For example, in order to understand the process involved in multiplying 28 by 6, it must be appreciated that:

$$28 \text{ times } 6 = 20 \text{ times } 6 + 8 \text{ times } 6; \text{ OR}$$
$$6 \text{ times } 28 = 6 \text{ times } 20 + 6 \text{ times } 8.$$

These are particular cases of the two distributive laws, namely:

$$(a + b) \text{ times } c = a \text{ times } c + b \text{ times } c; \text{ OR}$$
$$c \text{ times } (a + b) = c \text{ times } a + c \text{ times } b.$$

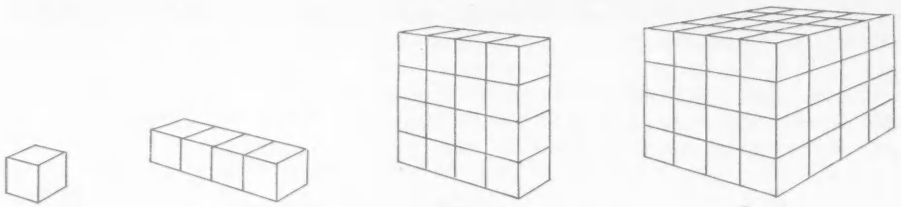
The former is clearly a particular case of the latter, and by Hypothesis B, if the concept is learnt at a more general level, it will have wider applicability. It must not be thought that the two laws are identical. In the first case the operator is split, i.e. the number of times you take another number can be split; in the second case the operand is split, i.e. the number you are multiplying is split. The reader will perhaps work out as an exercise a structured game on the balance for the first form, and a structured game with pegs or squares for the second form.

It is not necessarily intended that the pure concepts here alluded to should be formed in such a crystal clear explicit form as is indicated by the formal expressions of them in the above formulae. Children find it very difficult to be explicit; an implicit working knowledge derived from experience is probably enough as a basis for the understanding of the arithmetical process cited.

7. Notational and applied concepts

Here again we shall give some examples to illustrate how some of the rather difficult notational concepts can be made available to a larger number of children than hitherto, by means of structured games played with apparatus designed in keeping with the hypotheses A, B and C.

A piece of material, which will be referred to as the Multibase Arithmetic Blocks, or M.A.B., has been found very useful in accelerating the formation of notational concepts. The apparatus consists of pieces of wood, articulated on all faces into little unit squares, as shown on the diagram. It will be seen that the volumes of the pieces are in ascending



M.A.B. Material - Base 4

Fig 4.

geometrical progression, with common ratio 4. Other sets are included with common ratios 3, 5, 6 and 10. The pieces are referred to as: units, longs, flats and blocks, and there is a certain number of each of them in each set.

It will be clear that games with this material will be structured in the direction of the place value concept, a very difficult notational concept, but nevertheless one which lies at the basis of all arithmetical operations as now practised in our culture. In keeping with Hypothesis C the variables which go to make up this concept are made to vary. These variables are: (i) the base; (ii) the powers to which the bases are raised. The base is varied as the game moves from set to set, the power is varied by the simultaneous introduction of all the four shapes. It will also be noticed that the powerful dimension-aspect of perception is used to separate the different powers. Children brought up on these blocks should not confuse a^2 with $2a$, as a flat looks quite different from 2 longs, and if the linkage is once established, a quality difference between the powers will likewise be established. The different powers will acquire separate psychological existence.

The children first acquire the " feel " of the geometric progression. They make longs with units, flats with longs, blocks with flats, and they can even put blocks together and make a long block and so on. They then learn to exchange equivalent amounts of wood in different shapes, building a number of small pieces into a larger piece and splitting a larger piece into smaller pieces. In a more structured game they put blocks, flats, longs and units out in order, and if they are working to base n, they are told to go on exchanging until there are no more $n - 1$ pieces in any pile, except perhaps in the blocks' pile. It will be seen that this game leads children towards the concept of carrying in the addition and multiplication situations. The reader should not find it difficult now to devise structured games which prepare children for the concept of adding large numbers, including the possibility of carrying to the higher powers. Similarly, subtraction games can be devised, in which case the possibility of having to split large pieces into smaller ones must be prepared for. The games are usefully played on trays divided into three rows of four squares large enough to accommodate the piles, and marked *B*, *F*, *L*, *U* in the appropriate squares. This will be an additional aid towards the structuring of the game. These games are carried on to the base 10, when " difficult " subtractions, such as 1,000 — 356, are performed with thorough insight and satisfactory efficiency, in fact, the more difficult problems are more popular as there is more to do and so they are more interesting.

A natural follow-up to subtraction is division. This is easier than multiplication, as all the pieces are on the table, and all you have to do is share them out. Children greatly enjoy doing this and coping with the difficulties when there are not enough pieces to share out and they have to " change down " to smaller pieces. Formal division comes very naturally as the abstraction from such experiences.

The difficulty with multiplication is to get the children to understand that one of the numbers is an operator. Perhaps one should start with a number of doubling exercises, followed by trebling, and so on, but being careful not to use a multiplier greater than the base number. The pile to be doubled can be put in the first row, the doubling can be shown by putting two units on the *U* square in the second row, and the doubled amount of wood is then put in the third row, carefully arranged so that no pile contains more than $n - 1$ pieces.

Next would follow the discovery of the special properties of multiplying by the base number, which again is looked upon as somewhat magical by most children, particularly in the way they get the same numbers but larger pieces, and never any units. The " adding a nought " mystery is not a problem at all but a natural result of playing a structured game directed to generate that particular insight. The reader will now find no difficulty in seeing how a compound multiplication game can be devised. The children will, of course, need larger trays, although chalk marks on the desks will do just as well.

It may be objected that in the foregoing we have ignored Hypothesis A. It is quite easy, however, to provide alternative perceptual equivalents. Games with the abacus, worked again to different bases, can go hand-in-hand with the games described above. The abacus weans the child from the aid provided by dimension, but leaves the aid of the actual number of rings arranged in the right order on the rods. A further step towards the formalising of the process would be to use rings with numbers attached to them, and only put one ring on each rod. It is only a small step from here to the formal working of the processes on paper. It has been found that most children realise very quickly the " sameness " of the two tasks, i.e. the task with the blocks and the equivalent task with the abacus, and the abstraction process is completed without difficulty. The other intermediate stages are only required in a very small number of cases.

The usual objection to introducing a number of different bases is that it confuses the children. It is well to remember that what may be confusing to us, may not be confusing to the child. We are confused because we have thoroughly fixed the place value concept with a linkage to the base 10, and so we have to overcome a great deal of perseveration when working with other bases. Children who use this material presumably have not acquired the concept of place value and so there is nothing with which they could confuse it. The practical answer is, of course, that children are in fact not confused, the insightful learning of the notational concepts and the attendant techniques is very rapid by any standard.

Another important reason for using different bases is that it lays the foundations for the very general concept of variable. The manipulations in different bases are preliminary games for the later concepts of indices and logarithms. The essential component

concepts of these are the base and the index, and the multibase blocks provide an opportunity for varying these variables. A child brought up on the Stern blocks* is far less ready for this degree of abstraction than one would be if brought up on the multibase blocks, if Hypothesis C is correct. It should be clear, too, that a child brought up on the Cuisenaire rods* would be likely to be even less ready for these later pure concepts than a Stern-trained child. Further concepts that would be influenced by the choice of M.A.B. would include the binomial theorem, linear factors of quadratics and cubics and many others. The variability of the base will in all these cases have been an essential preliminary to the understanding of the algebraic, i.e. general nature of these concepts. Here is an example where the choice of games for the development of early concepts can profoundly affect the acquisition of later concepts, these maturing perhaps years after the early ones.

We conclude this section with a few words on applied concepts. In the spirit of the foregoing, the applied concepts will also need to be acquired through experience. Here, however, real life situations are not lacking and the problem is easier both because children in any case come across experiences which help to generate in them concepts such as weight, capacity, money-value, etc., and because classroom experiences of this kind are easy to devise. Clearly, a child will learn the concept of weight by comparing weights of objects, weighing them against each other and against standard units. He will learn length by measurement of objects in terms of relative lengths, then in terms of standard units. As this is already being done in a great many schools, it is not necessary to dwell on it here.

8. Some higher order concepts

We shall now give a few examples of how the apparatus can be used to help generate higher order concepts, lest it be thought that this method is suitable only for young children. The foundation to all these attempts is, in short, to put the child in the same position as the researching mathematician, and so to open up for him the joys of really creative thinking. As we have seen, this cannot be achieved if violence is done to the natural concept formation cycles by leaving out entire stages or by forcing the child into a framework he does not understand.

Let us consider quadratic factors. After a certain amount of experience of suitable structured games, the child will associate a square with the symbol A^2, a strip with the symbol A, and the inch squares with the units. It is assumed that other perceptual material has been used as well, so that these associations are not unique, for example, a triangle will also have been associated to the symbol A^2 or X^2. Also the concept of area should by now be fully operational. A structured game for factorising

$$a^2 + 5a + 6$$

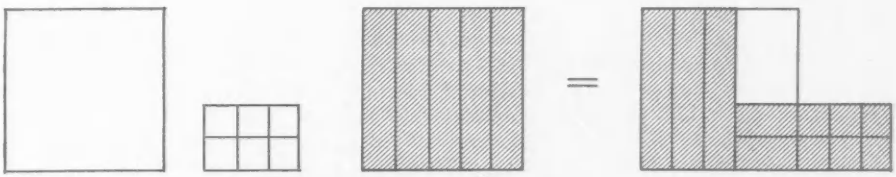
would be to provide a square, 5 strips and 6 inch squares and to tell the child to make a rectangle out of the pieces. This game can be repeated on the pegboard, varying the size of the square and so of the attached rows. This can be followed by giving them several squares and factorising such quadratics as $2a^2 + 5a + 2$.

*A variation of the index is built into the Stern apparatus but not the variation of the base. Neither is built into the Cuisenaire apparatus.

But it is the negative terms which children find really fascinating. These are introduced by being given " covering pieces " as well as ordinary pieces, the former being used for covering up the latter. When an ordinary piece is covered up, it is considered detached, cut off. Suppose, then, that we wish to devise a structured game for factorising $a^2 + a - 6$. The child is given a square, a strip and six covering pieces, as shown on left of Figure 5, and is told to make a rectangle. The task is, of course, impossible without adding and subtracting and so it is only fair to tell the child that he can always take two more strips out of the box, as long as he uses one as ordinary, i.e. for extending, and the other for covering. This means in effect cutting a piece off and putting it somewhere else. The problem is solved as shown on the accompanying diagram, shaded areas representing covering pieces.

Factorising $a^2 + a - 6$
Fig 5

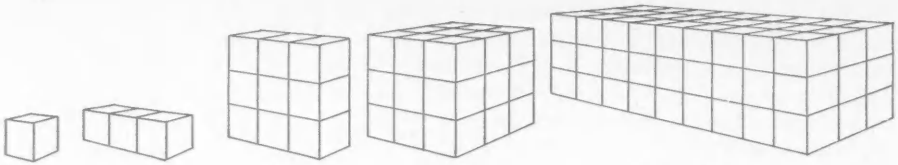
To factorise $a^2 - 5a + 6$, a child will naturally put the ordinary, i.e. positive pieces down first, and it is a short step from there to arranging the covering pieces so as to leave a rectangle showing.



Factorising $a^2 - 5a + 6$
Fig 6

This, again, is a good game towards the understanding of (-2) times (-3) being $+6$, if it is desired to start from $(a - 2)(a - 3)$, i.e. from building a rectangle whose lengths are $a - 2$ and $a - 3$. You cannot cover something up that is not there, so the six squares must be ordinary, not covering pieces.

We shall conclude this section with a few words about the law of indices and logarithms. With the M.A.B. the following hierarchy of shapes can be built.



M.A.B. Material - Base 3.
Fig 7.

taking the base 3 for convenience; when we reach the block, the next shape is 3 blocks put together, i.e. a longblock or *LB*, then next 9 blocks are put together to make a flatblock or *FB*, 27 blocks will make a blockblock or *BB*. There is no need to stop, except that we shall run out of wood from the boxes. On the other hand, a special series, consisting of pieces of unarticulated wood, can be constructed and carried much further, perhaps up to *BBB* or even further. If we denote the base by *a*, we shall have the following hierarchy:

U	*L*	*F*	*B*	*LB*	*FB*	*BB*	*LBB*	*FBB*	*BBB*	*LBBB*
1	a	a^2	a^3	a^4	a^5	a^6	a^7	a^8	a^9	a^{10}

It will soon be seen that multiplying by an *L* we move one step to the right and dividing by *L* we move one step to the left. Similarly, multiplying by *F* we move 2 steps to the right, and dividing by it 2 steps to the left. It is a small step from here to the law of indices. Blocks can now be constructed equivalent to combinations like a^2b^2ab where for example, *a* might be 3 and *b* 4. It will not be immediately clear that the structure can be rearranged into a cube. The analytically-minded might work out what sorts of shapes can be built with the material in $a^2b^2a\ b$, and find out that one of them must be a cube. The more constructive minded will build them all in turn and note them down. Either or both types of experience will enable the child to appreciate the beauty of the law of indices as an essence abstracted from such experiences. Some will regard it as a tidy set of relationships, others as different configurational possibilities. They are both mathematical insights, taken from different points of emphasis.

The concept of logarithm is now an extremely simple one to which to proceed. The numbers that figure under the shapes of the hierarchy are the logarithms of these shapes. For example, log. $LB = 4$, log. $BB = 6$, and so on. Having realised that *F* times $B = FB$ it does not take long to conclude that:

$$\log. F + \log. B = 2 + 3 = 5 = \log. FB = \log. (F \times B)$$

and the log. theorems appear as just another way of saying the laws of indices, which is, of course, just what they are. If the shapes are given numerically in the terms of the

number of units they contain, then it must be specified which box they have been taken from. For example:

$$\log_{\text{box } 3} 81 = 4, \qquad \log_{\text{box } 4} 64 = 3$$

and so on. The conventional notation is reached as a necessity as otherwise the shape cannot be identified.

To finish the story, what could be more natural than to call L a^1 and 1 a^0, to complete the hierarchy. The geometrical progression can now be continued to the left, by dividing the units into 3 thirds of a unit, which look like a tiny version of a flat, this in turn can be divided into three parts, each part then will look like a tiny long and so on. It is very natural to call these — 1, and — 2 powers, which then become the logs of the tiny pieces. With some practice on the conservation of the law of indices for these powers and logs., the enlarged concept will be safely anchored. To carry on to fractional indices and so to a richer harvest of logarithms, it is best to shift the notation, and call $BBBB = a$, for example. In other words, now log. $BBBB = 1$ whereas before it was 12. To be in keeping with what has gone before what could be more natural than to call $BB = a^{1/2}$ and $B = a^{1/4}$ and, for example, since $LB \times LB \times LB = BBBB$, $LB = a^{1/3}$, and so on. The shapes now acquire fractional logarithms equal to these fractional powers. An overall insight into fractional, positive and negative indices cannot be long delayed, if structured games along the lines indicated are played.

It should be added that the possibility of entirely abstract games should not be lost sight of. At what stage the average child would mature to be able to enjoy abstract games without any tangible material is not as yet known, since these games have not been made available to the average child up to the present. Only the very few are able at the moment to break through the morass of formalism to the beauty of the structure beyond, and those who finally decide to play with this structure are the ones who become mathematicians. Far too long has mathematics been the preserve of the few, and a kind of mathematical aristocracy has grown up that in a sense tries unconsciously to perpetuate itself by making mathematics too difficult for the many. It is time that the gates of this preserve were thrown open to all, so that yet one more creative activity could be opened up for the ordinary citizen with which to enrich his life.

9. Conclusions

It is not as yet possible to draw any hard and fast conclusions as to the practical working of the scheme under actual school conditions and so to give the full vindication of the theory here presented. It is, however, possible to state some qualitative results derived from trials in a number of schools. Schemes of individual mathematical discovery can be worked in large unstreamed classes throughout Junior Schools; a large

majority of normal children can understand the complex workings of the four rules of arithmetic in the decimal and other systems; normal 10-year-old children can learn the use of brackets, the properties of squares, the solution of linear and quadratic equations and the factorising of quadratic functions, if approached from the constructive point of view. In fact, it is possible to give children leaving Junior School a solid body of practical experiences, impossible to obtain from real life situations, on which a very extensive Secondary School curriculum can be based. There are almost limitless possibilities for enlarging the Junior School syllabus, by including such topics as theory of groups, usually reserved for University Honours courses.

There is, even now, sufficient evidence to suggest that mathematics can be introduced to a larger section of the child population than has hitherto been thought practicable or possible. This is done by co-ordinating the teacher's work with the natural process of concept formation in the child. It is a challenge to the teaching profession to devise ways in which this much larger body of children can be drawn into the mathematical workshop. By doing so, a large potential of future mathematicians, scientists and technicians would be created, whose practical bias is likely to make them extremely useful members of our increasingly technological Society.

Editorial Note

The two sets of material referred to in this paper and the instructional manuals which go with them are in course of production and can be ordered only from the N.F.E.R. through L.E.A.s. Their supply is subject to conditions regarding their use, including, in the case of the A.E.M., restriction to teachers who have undergone courses of training, details of which may be obtained from the Deputy Directors of the Institutes of Education in the Universities of Leeds and Leicester.

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Teaching Children to Read—III

READINESS TO READ

by E. J. Standish

Introduction

THE age at which children start their schooling differs from country to country. In the United States it is permissive at five but not compulsory until six, while in the Scandinavian countries it is postponed until seven or even eight. In Britain children are required to begin at five. In fact, one in a hundred of the children commencing school at this age will have already become familiar with school life, having attended a nursery school or class. This comparatively early beginning of schooling tends to create many problems and difficulties for the admission or reception class teachers in our schools which are specific to our educational system.

The interaction of maturational and environmental factors produces different rates of development in children, so that even though all the children beginning school come from a particular age group, they will evidence a wide range of mental development, and will react in varying ways to the demands made upon them by this new experience. Some children will adapt quickly and easily, whilst others may experience considerable difficulties. The act of starting school for the first time presents children of this age with different and sometimes unexpected events and patterns of behaviour, such as the daily temporary separation from the comparative shelter of the home and entry into the bustle and activity of the classroom. The individual school and its teachers demand specific achievements from the child, such as the ability to dress himself or to practice common courtesies. The ease with which a child settles down during his first term at school depends upon the interrelationship of the needs of the individual pupil and the demands made by the particular school.

When we consider the teaching of reading at the infant level, we need to remember that the child's acquisition of this complex skill depends upon a great many aspects of his development. There are first such obvious things as his general readiness to adapt to school and the ways of learning, his chronological age (five or " rising five "), his mental age, his stage of language development, the state of his vision and hearing, and even possibly such factors as his eye-hand dominance. Equally critical however may prove to be the possession of those specific abilities that are relevant to the exercise of reading skill, such as the understanding of the relationship of symbols and their meanings, the ability to make visual and auditory discriminations, the comprehension of space orientation, familiarity with a left-to-right approach, and a certain degree of eye-hand and motor co-ordination.

The biographical and longitudinal studies of children made in the past fifty years have provided us with considerable information about early development and the type of behaviour to be expected at different ages. Such " behaviour profiles " or age-group pictures are undoubtedly useful; they help the teacher, for example, to recognise certain types of behaviour as transitory, normal or abnormal. But they can be little more

than suggestive for a particular teacher faced with a particular class. In many cases the samples studied were small and not representative of children in general; in a considerable number the observations are based upon samples of children of above average intelligence, usually from superior socio-economic backgrounds. Also, as Valentine (1948) suggests, " one is often left in doubt as to whether a particular form of behaviour is common at the age, or reported because of its inherent interest." It is possible that the behaviour profile of a particular age group may produce unrealistic expectations on the part of the teacher, which can hinder both the pupils' progress and the teachers' success in meeting their needs.

For instance, Gesell, in his study of American children, *The Child From Five to Ten* (1946), although noting that his observations are only indications of the kind of behaviour which tends to occur at a given age and should not be taken as norms of behaviour, proceeds to report in some detail that the five-year-old likes to be read to and spends considerable time looking at books pretending to read. He continues that by six, children may be reading from memory, are taking more active parts in reading, and recognise single words. He also mentions regular periods of parental reading to the child, such as at bedtime or while the child is having his bath. Since the American culture has sanctioned the sixth and seventh years for beginning school, Gesell's six-year-old profile is largely concerned with school adaptation, whereas this important transition occurs much earlier for the English child. His descriptions of the six and seven-year-olds' reading habits and behaviour are interesting, especially for comparative purposes but a recent study carried out by the N.F.E.R. in sixty primary schools in Kent (Morris) probably is of more practical value to the teacher in this country, since it describes the situation which daily confronts the teacher of beginners and describes the extent of her task.

The Task of the Teacher of Beginners

One of the most interesting findings of this study was the extent to which the needs of the newcomers differ from school to school. Of the sixty schools, fifty-five were introducing reading to most of the children for the first time, but in the other five most of the children had already been introduced to reading by their parents, were familiar with books, and had mastered the mechanics of reading.

This suggests that the task of the reception class teacher must vary according to the nature of the pupils' home background. Some will be beginners in reading, whereas others will have already made considerable headway, resembling the children of Gesell's observations. Both types of children will probably require completely different methods and experiences in the teaching of reading and the range of their needs may well tax both the skill and the patience of their teachers.

As we have seen, some teachers will find that part of their work has already been carried out in the home. Undoubtedly, the child from the poor socio-economic area or the uninterested home will present a greater teaching problem in terms of the extent of the task, but the teacher who is presenting reading to pupils already familiar with the skill will have a different but equally difficult challenge. For instance, the Kent study showed that the children who had been encouraged to read at home were often being set a far higher level of attainment and in consequence there was greater emphasis on

competition and on success or failure. Parental interest exerted pressure which influenced school aims and even made it difficult for head teachers to change their approach, especially if this should be in the direction of a less formal organisation or procedure with a consequent lessening of competitiveness. The interest of the home in the child's progress and the desire to purchase the reading series used in the school for home practice, often made difficulties for the teacher particularly in the provision of fresh, unfamiliar reading material for school use.

Teachers who are mainly concerned with the problem of perfecting and exercising a skill already acquired at a rudimentary level, probably find that one of their greatest difficultues is to enable each child to set himself a realistic level of aspiration, neither too far below nor too far above his level of ability. At the same time they have to maintain his active interest in the subject.

Teachers who are faced with the task of introducing reading to their pupils for the first time have a different set of problems. If the parents are uninterested or unable to provide the appropriate pre-reading experiences before the child comes to school at five, then the teacher must create these experiences, and provide an environment in which these children can find an interest in reading and an understanding of its importance. It seems likely, however, that the value attached to the attainment of this highly complex skill is predominantly a middle class one, and that the motivation to read is less prominent in poorer socio-economic areas. Children from homes in such areas are less likely to want to learn to read—their lack of interest being an expression of their culture, of values approved by parents and siblings, and instilled from birth. It need not be solely through lack of parental interest in the child's progress but rather because the patterns and habits of home life simply do not provide the opportunities likely to be valuable as pre-reading experiences. For example, the bed and bath-time reading sessions by parents reported by Gesell are likely to be confined to the homes of good or high socio-economic status with relatively few children, where parents are able to spend time with their children. Inglis, in his review of recent investigations [*Studies in Reading* (1948)], points out that " the literature on the subject of the relation between reading and the social environment is scanty, and much remains to be done to show what is the amount and what are the effects that follow from being in an environment impoverished in experience, idea and word."

Some of the Kent teachers were faced with the problem of teaching children who came from homes where there was little value attached to the skill of reading. These teachers had to cope with the low general ability of the children, a lack of parental help and encouragement, and in some cases with the added problem of the illiteracy of the parents themselves. In these schools, a high proportion of the newcomers were unable to read, showed inadequate language development and sometimes were even unable to talk intelligently, giving at first the impression of being dull. It is heartening to note that usually by the end of the first school year, the encouragement of the teacher had enabled them to express themselves with a tolerable degree of fluency. The task of the teacher of such children seems to be that of sustaining the initial eagerness to learn which is so often demonstrated during the first few weeks of beginning school when everything is exciting and an adventure into a new and different world, while providing those

experiences and the training necessary for the development of skills basic to the reading process.

The close relationship between reading and home background is not a recent discovery, but the Kent study does enable one to realise that different kinds of education may be needed in infant schools in different areas.* This is probably possible where the social background is homogenous but becomes much more difficult where the school draws its pupils from widely differing social backgrounds.

Ascertaining Stages of Reading Development

Children who can already read on going to school are probably best helped by a teacher who uses a reading attainment test to distinguish between those who, already competent readers, should be encouraged to choose more difficult material, progressing at their own rate, and those less advanced who need further guidance, instruction and practice at a more elementary level.

The problem for the teacher whose children cannot read on entry is to discover how ready they are to learn and what experiences or training they still need. The notion of readiness comes from the field of child study, and carries the suggestion that there is an optimum time for any particular learning task. It is similar to Havighurst's (1953) " teachable moment " which is described as the moment when, because conditions are most favourable for the training task, efforts at teaching, largely wasted had they come earlier, give gratifying results.

In the case of reading, it is likely that the moment of readiness depends for the individual child on: (*a*) his general level of learning ability or intelligence, (*b*) the adequacy of his sensory equipment and the stage of development of his perception, including the capacity for visual and auditory discrimination, (*c*) his language development, (*d*) his background experiences, and (*e*) the strength of his interest in learning to read. Clearly, reading readiness involves a number of complex and interacting abilities and skills. It is possible there may be a tendency to compensate in some other direction than that in which there is a marked deprivation or deficiency, but it is likely that there is a minimum level which has to be reached in all directions before the child is ready to learn to read and can benefit from formal instruction. However, we should remember too, that development in one direction may markedly affect growth in another: for example, the relationship between language and intelligence. As yet we know relatively little about such threshold requirements or the possible combinations of stages of development in the growth of the various abilities and skills.

The idea of reading readiness then, is that there is a " teachable moment " when the efforts of child and teacher are likely to produce the best results and not prove ineffectual, The difficulty for the teacher is to discover this, and not to leave a child who is ready, to become bored and uninterested, nor to introduce a child to the skill who cannot as yet cope with the demands so made upon him. Many teachers do this more or less effectively by developing their own powers of observation, and, through experience, become capable of recognising the evidence of such readiness in their pupils.

*The N.F.E.R. are proposing in the near future to carry out a study of the problems of teaching children from areas where the home provides little encouragement, so as to ascertain the most effective methods of teaching reading where it is predominantly the teacher's responsibility.

Tests of Reading Readiness

It would obviously be an advantage to many teachers if there were some objective way to supplement and refine these unaided observations, especially when time does not allow prolonged trial and error. Researchers have attempted to devise tests to measure this composite factor of reading readiness and generally such tests consist of a number of sub-tests of the paper and pencil kind. Most of the tests are intended for group administration but a few include sub-tests for individual use only.

Such reading readiness tests vary in many important respects although they all have some features in common. Of the eight batteries described later in this issue, all use a test of visual discrimination; six use tests of vocabulary; three use motor tests; two, tests involving the following of directions; two tests of the reproduction of patterns and shapes from memory; and two make use of tests of relationships.

Since the definition of words and the naming of objects are used as items in a number of widely-used intelligence tests, it is possible that both the reading readiness test and the intelligence test overlap to some extent. Some attention has been given to the relationship between tests of intelligence and tests of reading readiness and in the Scottish *Studies in Reading* (1948) Inglis reports that " the general conclusion is that mental age is slightly inferior to reading-readiness measures in predicting reading attainment," while Robertson and Hall (1942) note that a combination of the two does not notably increase predictive value. Indeed, Robertson and Hall have argued that existing reading readiness tests measure primarily the same thing as existing tests of intelligence. As yet there seems to have been no detailed examination of the content of reading readiness and intelligence tests to discover the extent of their differences and similarities in the type of items used.

It has long been held that, apart from tests of intelligence, the tests that measure the factors most frequently involved in reading readiness are those concerned with the perception of visual material; and, of these, the type of sub-test that correlates most highly with reading attainment in the early stages appears to be word perception rather than tests using geometric forms. It would then appear that the most effective type of reading readiness test is, in fact, a test of reading achievement. Witty and Kopel (1939) put forward this view, stating that " the best index of readiness is the child's actual ability to read letters and words in meaningful units and sequences." This may be true of American children who are a year later in starting school and may have developed an interest in words and letters in their fifth year, but we do not know whether children in this country do show such a preliminary knowledge of reading elements which would be predictive of later reading performance. Indeed, Inglis suggests that " investigations are required in the field of reading readiness in Scotland and England. An interesting starting-point would be to apply some of the American tests of word discrimination in order to discover if a sufficient degree of readiness for dealing with print existed at age five, and to what extent it differed from the readiness shown in these tests by American children at age six."

J. B. Stroud (1945) suggests that " low correlations between perception of designs and perception of words, letters, and digits may be due to differential practice, not to differences in innate capacities involved," and puts forward the view that there is a general factor of visual perception in achievement in reading. A recent study by Goins

(1958) has shown that there seem to be two factors not one involved. This study found that visual perceptual tests without any reading or verbal content could produce substantial correlations with reading test scores of first grade pupils on tests administered towards the end of their first school year. The results of a factor analysis carried out in the course of this research revealed that a relatively subtle type of perceptual closure is more closely related to reading achievement at the beginning level than is the skill measured by the perceptual-speed type of sub-test usually used in measures of reading readiness. The use of verbal material in reading readiness tests may distort correlations with reading skill, and it would seem from the evidence of this study that visual perception may be as important in the learning to read stage as familiarity with print. This would suggest that current reading readiness tests would need to be revised since the tests of visual discrimination they use are predominantly measures of the ability to perceive and to keep in mind a perceptual whole, whereas this study shows that visual perceptual ability also involves strength of closure, that is the ability to keep in mind a configuration against a distraction. Goins found that tests which measured strength of closure had a substantial common variance with reading achievement at the first-grade level and that several of these tests were better predictors of reading success in the first grade than were the two standard intelligence tests used with the children. Readiness tests which used these types of sub-test could be used to differentiate early and easily the type of pupils who are likely to benefit from modern reading methods which emphasise reading by " wholes " from those who are likely to need different instruction.

The Use of Reading Readiness Tests for Diagnostic Purposes

The concept of readiness is increasingly being revealed as a complex structure and the principles behind the construction of tests to measure it are changing as time and research reveal the limitations and possibilities of both the concept and its measures. The method of assessing the predictive value of reading readiness tests most often used has been to accept later reading achievement as the criterion of correct forecast. Robertson and Hall analysed the data published up to 1941, and found that the median correlation between reading readiness tests and measures of reading success was .58, while the median correlation of teachers' ratings (on rating scales) and measures of reading success was .62. Neither of these is very high nor would they lead us to place great confidence in the estimate concerning any individual child. It is evidence such as this which may have caused the designers of reading readiness tests to re-examine their ideas about the scope and function of such tests. Most of the authors have put forward their results as tentative conclusions because of the obviously complex nature of reading readiness and the subsequent inability of test measures to account for all its facets. Witty and Kopel (1939) made the comment that " only when the total readiness test score is very high or very low does it (the reading readiness test) assure with any certainty the presence or absence of readiness. Readiness devices are somewhat helpful, however, in that their sub-tests provide evidence concerning the relative development of several fairly specific abilities related to reading achievement." It is this type of observation which may have led the authors of the new type of reading readiness tests to design them as measures of the specific skills required in the composite skill of reading. The items are designed to dis-

criminate between those children possessing the contributory skill and those who are deficient in it, and items are selected on the basis of their ability to do this. The authors of such tests are more concerned with " built-in " validity than with validity of prediction. They expect their tests to provide the data for a profile of the stage of development of the abilities the child brings to the reading situation rather than to give a total score which may be misleading in its generality. Such tests are useful guides to the teacher because they are diagnostic rather than predictive: they ascertain individual strengths and weaknesses rather than predict possible but not inevitable levels of achievement.

It is this changing concept of the function of reading readiness tests which possibly has given rise to the confusion over whether such tests can be strictly described as achievement tests. The earlier type of test, especially that which dealt with verbal materials, was undoubtedly a test of elementary reading and may well have been as effective a predictor as it was, because it discriminated between children who had already acquired the rudimentary skill and those who had not. The ineffectiveness of such tests to discriminate between other than broad groupings of success and failure led to the development of the diagnostic aspect of such tests. It can be argued that these more recent sub-tests involve reading of a sort if one uses the term to cover the ability of being able to perceive relationships between symbols and their meaning and not simply the translation of purely verbal material.

To illustrate the nature of the problem at this earliest of reading stages, the analogy to learning tennis is perhaps useful. One can test separately the ability of the individual to see and follow the movement of the ball and to co-ordinate eye, hand and foot, as one can record the length of reach or the strength of wrist movement. If all these contributary skills are present to a sufficient degree, then the act of learning to serve will be possible and probably easy to acquire. If, however, any of these contributary skills is undeveloped or untrained, this is likely to hinder or even to prevent the achievement of a successful service. The older type of reading readiness test resembled the situation in which the player is given a racquet and a ball, and judgments about his future tennis form are made, from what he manages to do with them—if he is able to do anything.

The Value of Reading Readiness Tests

Undoubtedly, reading readiness tests can be useful tools and are increasingly gaining in accuracy, precision and clarity of purpose. A good one enables the teacher to discover, or what is perhaps even more important to create, the " teachable moment " for each child, replacing the passive approach with its stress on maturational limitations, with a more active and initiating attitude. These tests can be of general use with new entrants or with those children admitted during a term, enabling the teacher to obtain an immediate impression of a child's needs and capabilities rather than to wait and acquire this by the slower process of personal observation.

On the other hand, the construction of such tests is a long process requiring continuous and detailed research. Since most of them have been designed in America, some of the items and the content are liable to be more familiar in that culture, and the norms established on American school populations rarely go as low as the age levels required in this country. Some tests seem to be unevenly balanced in construction, and their

designers do not always seem to be aware of skills other than those they are measuring. Of course, the difficulty now is that as workers in this field obtain more knowledge about the complex nature of the ability to read, they have increasingly to decide whether to design batteries of tests which measure a wide range of different skills each at a more or less superficial level or whether to construct a test of one particular ability considered relevant to reading and consisting of several sub-tests each measuring one of the different forms this ability may take. For example, there seems to be a move away from the simple test of visual discrimination towards a series of sub-tests covering various types of visual perception.

Finally, some authorities and educationalists would question whether children of this age can in fact be tested in groups, and would suggest that tests do not provide any information which could not be obtained from sustained and directed observation on the teacher's part.

Teachers' Attitudes Towards and Recognition of Reading Readiness

Teachers in the Kent investigation, although having considerable experience in measuring ability and attainment by means of standardised tests, were unfamiliar with reading readiness tests. The majority of the teachers, however, believed in the concept of reading readiness but found it difficult to say how they assessed it.

ATTITUDES TOWARDS READING READINESS OF THE HEAD OF 60 SCHOOLS

Attitude Towards Reading Readiness	URBAN					RURAL		Total
	J.M.&I.	J.M.	J.B.	J.G.	I. & Std.1	J.M.&I.	J.M.†	
Believed in ..	14	3	0	1	8	19	0	45
Did not believe in	1	1	0	0	0	2	0	4
Unable to answer	0	3	2	1	0	4	1	11
Total ..	15	7	2	2	8	25	1	60

At first, most stated that assessing reading readiness was a matter of " instinct " but when they were asked to explain this in greater detail, all but six were able to express what they meant in more concrete terms. The most frequently mentioned method was that of noting whether the child showed a desire to learn to read—by being interested in books, looking at them, or asking about words. Some teachers mentioned the choice of

†J.M. & I. = Junior Mixed and Infant.
J.M. = Junior Mixed.
J.B. = Junior Boys.
J.G. = Junior Girls.
I. & Std. I. = Infants and Standard I.

books rather than sand and water in a free choice period, whilst others looked for skills such as the ability to interpret pictures, knowledge of the primary colours, and being able to carry out directions. Other indications were said to be the child's social, physical or language development. The determination of whether a child was ready to read rested primarily on the teachers' ability to observe those forms of behaviour which they had come to accept as indications of readiness.

The four schools who did not believe in the concept of reading readiness were amongst those who started formal teaching with the entrants. In this study a formal approach was found to be significant at the one per cent. level when correlated with reading attainment scores, but after eliminating the effects of Urban/Rural location, Socio-economic Status and School Size, this correlation was no longer significant. The difficulty in evaluating this evidence is that we do not know precisely what the teachers in Kent understood by the term reading readiness nor to what extent their attitude actually affected their teaching methods, that is whether they waited for signs of readiness or whether they actively set about developing those attitudes and abilities which they had come to recognise as signs of the readiness to learn to read.

Conclusion

The Kent study shows that the task of teaching beginners varies according to the children's home background; that some are indeed teaching beginners whilst others are teaching children already familiar with the skill, and that the subsequent rate of progress is likely to depend to a large extent upon an accurate assessment of the pupil's level of reading attainment or reading readiness during the first few months at school. This may be determined either by personal observation or the use of the appropriate test measures. The changing conception of reading readiness tests illustrates the importance attached to the early school years. Increasingly, it is being realised that it is not necessary to wait for symptoms of backwardness to develop, but rather that every effort should be made to diagnose weaknesses as soon as possible in the child's school career so that the appropriate measures of guidance and training may be adopted. In the field of test construction in the past the approach has resembled the attitude of the Kent teachers, being predominately intuitive but it would seem that values which have been implicit are now being made explicit. The revaluation of aims and purposes in this field should undoubtedly improve the accuracy of these measures, and a more general awareness of their scope and limitations should increase the value of such tools for the teacher in the classroom.

As the child grows older, individual attributes become more important but at this early stage much depends upon the teacher, upon her powers of observation, her knowledge of methods and techniques, and the ability to inspire that confidence which stems from a certainty of purpose and which avoids the type of classroom confusion in which faults can easily be acquired that with time and repetition become so difficult to eradicate. At present, we know very little about the effect of teachers' attitudes on the effectiveness of methods of teaching reading. We know children come to school with a variety of reading and pre-reading experience, but there is relatively little information as to how teachers recognise and evaluate their pupils' background and previous experience, or of

how this knowledge affects teachers' attitudes and their subsequent choice of teaching method. A particular method of teaching reading may be more effective with children from a particular background where as a teacher's choice of method can be determined either by her awareness of these background influences or by the satisfaction of her own personality needs which a particular method provides. To teach beginners, as with teaching any group, the happy medium is probably to satisfy the individual needs of the pupils by a method which can also be personally satisfying to the teacher who has to use it.

Editorial Note :

An appendix dealing wiih Group Tests of Reading Readiness will be published later, owing to lack of space in this issue.

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INTEREST TESTING IN EDUCATIONAL AND VOCATIONAL GUIDANCE

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Introduction

IT is often believed that a strong interest in a task, whether at school or at work, is an essential or at least a vital factor in the achievement of the best results. Candidates for a particular course of education or a type of work are often asked about their interest in the task which they seek to undertake and frequently much is based on their replies. There are, however, assumptions underlying this acceptance of the importance of expressed interests which should be examined.

It is, for example, important to know whether in fact a pattern of interests exists which possibly along or in alliance with other qualities distinguishes the successful from the unsuccessful entrants to particular school courses or occupations. Does research evidence justify the commonly-held belief that candidates for training as teachers, farmers or craftsmen should be interested in " book-learning," " the out-door life " and " practical things " respectively? Can we then show that success in an engineering course and in the profession of engineer, let us say, requires a pattern of interests distinct from that exhibited by successful art students?

If such evidence exists, then advisors and selectors are faced with a second task, that of evaluating the credibility of the candidate's statements of interests and of assessing the relationship between such an expression and the educational and vocational pattern. Differences of sex, of home and school background and in the amount and kind of information about the desired career available to the candidate may make his statement unrealistic or unreliable—characteristics which in fact are often found to be typical of the expressed interests of adolescents. Accordingly, apart all together from other considerations, it might be unwise to encourage a career with British Railways upon the evidence of an isolated interest in " train spotting " or to have much confidence that a pupil's strong liking for history lessons will predict outstanding success as a history teacher.

This leads to a further and more subtle point. Advice based upon expressed interests may indeed prove to be excellent but for reasons other than those for which they have been given. It happens, as indeed we have all seen it do, that appetite grows by what it feeds upon and that the distinctive interests shown by pupils following a given course or by successful members of a trade or profession have, in fact, been created by the study, training or experience they have had. If this is generally or wholly true then the expression of an initial interest will tell us little in itself; what we need to know is whether the

individual has the disposition to form interests of the kind which are an essential element in success. The question in fact should be put in the general form; how far can we judge the basic psychological needs of the student from his present interests and how far does this presumably fundamental pattern predispose him to form those interests which will foster his chosen studies and career? Practically, too, we need to know how such initial interests or their underlying needs can be measured efficiently and simply enough to form valuable components of the guidance procedure.

On most of these points there are a number of unverified opinions and, on some at least, a considerable research literature which it will be worthwhile to summarize. For this purpose it is convenient to deal with the reports in three broad sections: the contributions from America, other countries and the United Kingdom.

1. Research Evidence from America

There is a difference in purpose between American and European guidance procedures which probably reflects differences in basic educational and social concepts and consequently in educational organisation. In several European countries there is a distinct break between the primary and secondary stages occurring, for example, in this country at 11+ and in Holland at 12+ years. Here the emphasis is upon the two-fold task of selecting groups of children who differ in general ability and special skills and then allocating them to suitable courses of secondary education. Only later, towards the end of the secondary school course, is vocational advice given, and the scope and content of this guidance are largely determined by the type of school to which the child was originally sent.

In the American system there is no sharp organizational differentiation between schools in the early adolescent years and guidance at its best is a continuous process. The main break occurs when the adolescent in fact leaves full-time education to start work. Guidance at this stage tends, therefore, to be mainly vocational in character, seeking to help boys and girls to choose careers in which they will have some success and satisfaction. It is to be expected that this difference affects the way in which the role of interest measurement is studied on the two continents, the one seeking to find occupational patterns of interest and the other studying individual bias to, for example, technical or academic studies as a basis on which to determine suitable courses of education. The difference, however, is not sharp and is one of emphasis; in fact, guidance of both kinds is given in America and Europe. Hence, American work provides leads of many kinds, and at least until the end of the last war was almost the sole considerable body of information on the measurement of interest.

From this mass of work emerged five important studies from which most of what follows is taken. The first, by Fryer, brings together most of the research on interests before 1930; the second, by Strong, brings the analysis up to date. In addition the work of Kuder is of importance because of its influence upon European measurement techniques, and of Ginzberg and Super because of their attempts to assess the true role of abilities and vocational interests in the choice of a career. It is of value to consider their evidence at some length as it studies the basic issues both of the nature and measurement of interests.

(*a*) *Fryer*

From scores of research reports Fryer attempted to isolate those aspects of the nature of interests which he considered to be important for the purposes of giving educational and vocational advice. One of his main concerns was to investigate the possibility of predicting an individual's success in an occupation from a previous measurement of his interests. Prediction, however, depends upon several factors. Given the measuring instruments it is essential to try to discover whether there exists an occupational pattern of interests whose possession by a candidate for entrance to that occupation would considerably aid a subsequent high achievement. Fryer concluded that it was possible to isolate interest patterns which distinguish groups of people from each other according to their type of course or career—for example, groups of arts students from groups of engineering students, and dentists from farmers. He concluded, however, that it would be rash to base vocational and educational guidance mainly upon a coincidence between the individual's pattern of interests and that displayed by the educational or vocational group he wanted to enter. He also found evidence that not only the type, or quality, of interest pattern was important but that the number of the isolated interests which formed separate strands of the pattern were also associated with success, but in a different way from that which popular opinion holds to be true. It is sometimes thought that a "Jack of all Trades," handicapped by the number and variety of his interests, " is master of none." When, however, a number of eminent people, chosen from the American " Who's Who," were questioned about their personal interests it was found that many and varied interests characterised those of markedly high achievements. Other studies showed that the converse was also true—that people with few interests were often those who achieved little satisfaction in life and little success in their jobs. Later, this conclusion was found to be true in Europe.

However, isolating such vocational patterns is of little value if interest patterns themselves are unstable or the measurement of them is unreliable. The interests of adolescents are often thought to be notoriously fickle and Fryer could find little evidence to challenge that view seeriously. In fact, he summarised the evidence by stating that there are only 50 chances out of 100 that the expressed interests of a " teenager " would remain the same over a period of one year—data which does not give confidence in the possibilities of prediction.

Some of this change may be attributed to a lack of vocational knowledge on the part of the adolescent and to the subsequent widening of his educational and vocational horizons with fresh experiences. For example, a student may state an interest in " teaching geography " as a career and study accordingly. At the beginning his interest in this subject will be paramount but as he studies the wider aspects of the discipline, inevitably he will come into contact with history, geology, meteorology and other branches of knowledge previously beyond his range of experience. His interest, being stimulated by one of them, may very well encourage him to take it as an " Honours " subject and eventually lead him to work in the Meteorological Office or a Petroleum Company instead of with a Local Education Authority as was his original intention.

Fryer quotes many such examples of the way in which vocational ambitions deviate from the course originally planned by the individual as a result of coming into contact

with new interest stimuli. This, of course, has important implications for those who plan the curricula of our secondary schools. In particular, it calls into question the wisdom of allowing children to choose a relatively few topics to study too early in their school life. It will be valuable to note whether the European evidence supports this plea for a varied rather than a restricted syllabus.

One further pertinent question may be posed: are interests strongly affected by ability? If they are then the objection, put forward below, to interviewers rating the interests of students must be withdrawn, and in fact if the connection is at all strong, then the task of measuring interests might perhaps be better done by using the techniques for measuring ability. However, the balance of the evidence shows that the interrelation is complex. It is true that able children and adolescents are likely to have a greater number of more varied and intellectually more challenging interests than the less able, a fact brought out in Terman's studies and to some extent by the work of Strong referred to later, but differences are probably qualitative and related also to non-intellectual personality variables. Hence, in practice, it is found that the two aspects—ability and interest—as tested are relatively independent and that a measure of one does not give a good estimate of the other. This is Fryer's conclusion; later, Vernon found evidence to support it for English groups.

For the purpose of measurement Fryer accepted a distinction between " subjectige " and " objective " expressions of interest and concluded that a person's interest in an object or activity was expressed " subjectively " by a verbal statement of like, dislike or indifference whilst an objective expression of interest would be shown by the person's real or operational reaction to the object or activity.

The two expressions do not necessarily coincide. If, for example, the candidate is asked to express his interest in different school or college courses then he may state verbally that he likes engineering rather than art. An objective observer might, however, see the same candidate in his spare time rejecting an engineering activity such as dismantling a bicycle in favour of sketching a nearby church, an example which serves to illustrate that the only really objective statement of an interest (or an aversion) will be what a person does when he has the opportunity.

This is not to say that interest, or lack of it, expressed verbally in response to a question is a totally unsure guide; it is to point out that because a verbal statement is different in certain essential ways from the action it describes, it may provoke a response different from that which could occur in a concrete situation. However, corresponding roughly to the two ways, the subjective (verbal) and the objective (concrete or operational) expressions, two techniques have been devised to test interests, each with advantages and disadvantages.

(*i*) *Subjective Interest Measurement.* The crudest form of subjective interest measurement is the one commonly used, and on which much is built. It consists of asking a candidate in a personal interview to state the limits and degree of his interest in certain subjects, objects or activities. Obviously, this procedure is open to grave errors which may invalidate the replies to the point where they are useless or misleading. The candidate may have thought about the questions very little or have little knowledge of the

topics mentioned by the interviewers. Even if he has studied the matter, his reply may be biased by considerations other than those of purely personal interest. Many a school task has been undertaken to please a teacher and many a candidate for a job has claimed a recreational interest to which he is secretly indifferent, in the hope of creating a good impression on his panel of interviewers. When the question is " open-ended," usually in the simple form, " Tell me something about your hobbies," it may be even worse. In neither case is there any real basis of comparison between candidates and the assessment of patterns, strengths and weaknesses relies entirely upon the intuitive, unchecked judgment of the interviewer.

Some of the crudity can be taken out of this form of assessment by the use of questionnaires. The usually numerous and standard questions serve to stimulate thought on the part of the candidate about the matters under discussion and to present each with a more-or-less similar situation. However, there is at once the problem of how a complex battery of different questions can yield from the mass of detailed answers, a simple and easily understood statement about interests. Also, reactions to isolated or even to a large number of questions concerning interests in topics such as occupations, hobbies, school subjects and personality characteristics may not provide a reliable basis for interest testing. This has lead to the development of the more objective Interest Inventories of which the best-known are those of Strong and Kuder which are considered below.

(*ii*) *Objective Measurements of Interests.* One common method, often attempted at an interview, involves the assessment of a respondent's interests by other people. Generally, this takes the form of rating him as having shown over some considerable period, high, average or low interest in a given school subject. Research evidence indicates that such assessments of interests are often unjustifiably influenced by the ability of the pupils in that particular school subject. Another objection arises from the inability of most people to grade degrees of interest satisfactorily into more than five groups, such as:

Strong Interest Interest Indifference Slight Aversion Strong Aversion

Indeed, some research workers advise the use of only the first, third and last of these groups in guidance procedures.

To overcome some of these problems several lines of development have been explored which attempt to give more objective measurements and to get nearer to the overt situation in which an interest is displayed in action. One of the most common is the Information Test technique. This is based upon the assumption that a person's knowledge of a particular school course, job or field of interest will be greater if he has, in fact, already shown interest in it, and therefore acquired some special knowledge. Conversely, aversion or indifference will show itself by comparative ignorance. For example, to test an objective interest in woodwork the respondent might be given a series of drawings of tools or joints which are encountered in the craft. If he is interested in woodwork and has reinforced his interest by making models in his spare time then it is reasonable to expect him to be able to name more items with greater accuracy than someone who dislikes this activity and consequently only undertakes it in times of dire need.

However, as Fryer concluded, tests of this kind tend to be heavily influenced by general ability, particularly if they attempt to include too much detail, are too complicated or sample only a small area of the field to be tested. On the whole, he was cautious about recommending this type of technique and therefore surveyed other methods as well.

Among these is the Free Association Method, whereby the subject is given an interest stimulus in the form of a key-word which may come from the technical vocabulary of the craft or vocation concerned. The subject is then asked to state or write the first word which comes into his mind, if the discrete variation of the test is employed or, if the continuous form of the test is used, he is asked to continue recording words until he is told to stop. One of the earlier users of this technique was Wyman who collected 120 words, to stimulate free associations by the discrete method and equally distributed between the three fields of intellectual, social and activity interests. It has been used successfully with American children between the ages of 8 and 15 years.

Three other techniques are also worthy of note. Burtt experimented with two methods of testing objective interests. The first assumes that people learn more effectively if the process is accompanied by the pleasant feeling of interest rather than the unpleasant feelings of indifference or aversion. The second is based upon the notion that the stronger the degree of interest in any given task the less likely is it that the subject's attention will be distracted from his task. However, Fryer suggests that the first method is more a test of verbal ability and the second a test of motivation rather than of interests—a suggestion which illustrates some of the complexity of the issues involved.

Research workers have also tried to take into account the play interests, the collections made, the amount and type of reading and other leisure-time activities of school pupils as being objective reactions to interest stimuli. Although Lehman developed a pencil and paper test based upon this principle in America, the most common assessment of these stimuli in this country remains the face-to-face interview and the questionnaire.

Fryer concludes his study of the techniques of measurement with a recommendation that a minimum test battery for children between the ages of twelve and sixteen years should include the following components:

(i) Estimates by others (e.g. teachers) of the leading educational and vocational interests of the children.

(ii) Measures, which have particular reference to the pupil's present and possible future courses, of:

(*a*) Subjective Interests (e.g. Garretson's Preference Questionnaire);

(*b*) Objective Interests (e.g. Wyman's Free Association Test and Lehman's Play Quiz).

However, the tests which Fryer recommends for use with school children are of American origin for use under American conditions, and they could need a lot of adaptation and research before becoming of value under British conditions.

(*b*) *Strong*

The work of Fryer and his contemporaries was carried out during the early formative period of the study of interest measurement. Although he poses pertinent questions as to the value of such measurements his study of techniques is more a survey of possibly fruitful lines of development than of refined methods and well-tried instruments.

The conclusions of some later American reports are more optimistic, perhaps as the result of the greater experience they have gained in marking and using interest tests. It is also interesting to note the greater emphasis which recent American research places upon vocational guidance. In this particular field one of the best-known research workers is Strong, who has developed an important interest test and by its use over a quarter of a century has collected some valuable data the latter part of which bridges the gap between our own day and the date of Fryer's work.

In constructing his *Vocational Interest Blank* he assumed that patterns of interest exist which distinguish between different vocational groups. If the research evidence supports this assumption and the measuring instrument proves to be efficient then educational advisors would have a powerful tool with which to guide students towards courses leading to their chosen career.

Strong collected a list of hundreds of items such as " to be an actor," " to play bridge," " to teach children " and " people with a hooked nose " for which the respondent had to state his like, dislike or indifference. It will be noticed that these are of two types: those like the first and third which have evident relevance and face validity and those like the second and fourth which seem irrelevent or even frankly ludicrous. However, Strong is concerned to get two kinds of information. To items of the first evidently valid type the answers are probably of value by themselves. Strong's inventory, however, is interested in the pattern of scores and not in the individual answer. For the purposes of giving advice about taking an engineering career, for example, apparently irrational dislikes—for people with hooked noses—may be irrelevant, but if it is empirically shown to characterise engineers and to distinguish them from people following other vocations then, added to other similarly discriminating items, it can form part of an efficient instrument. In fact, of course, later versions of certain items of this type, though they may contribute to discrimination, had to be excluded because they tend to antagonise the respondents. Others, more innocuous in form however, were kept in.

The original list of items was given to a general group of people who pursued a variety of occupations, and to groups of people engaged in only one career, such as engineering. A minimum of 500 people for each group was preferred, although Strong found it impossible to attain this ideal with every group. Respondents were asked to record whether they liked, disliked or were indifferent to each item and each reaction was accorded a positive, negative or zero score depending upon whether it distinguished between the particular and the general groups. The items which significantly distinguished engineers from the general population could then be used to indicate candidates who had a pattern of interests approximating to that characteristic of those already successfully engaged in the occupation.

Patterns of interests have been isolated in this way for about forty male and nearly thirty female occupations, whilst special scales have also been developed to test occupational maturity and the level of occupational ambitions as expressed by interests. The test, however, has not been widely used in Europe, although one example of its use is quoted later, because of its several disadvantages. The isolation of occupational interest patterns is a laborious task and its American form cannot be used in this country without considerable adaptation. Primarily, it was intended for use with students of the American College level, which includes age groups from about sixteen to twenty years and in content it is rather too difficult and lengthy for use with younger pupils—for example, in an " 11+ " examination.

It will be readily understood, too, that scoring this test makes such heavy demands upon the time of the marker that large-scale application is impossible unless machine-computers are available. Reference must also be made to the warning given by Benton and Kornhauser, Vernon and Parry that this type of test is open to " cheating " on the part of the respondent. However, whilst noting the disadvantages attached to this inventory, the balance of evidence supports the view that the data obtained from its use are sound and valuable.

By using the Vocational Interest Blank with a group of university students, Strong obtained important evidence about the stability of vocational interests which, as Fryer found, he concluded to be an essential prerequisite of any attempt to use interest measurements for the purpose of prediction. His sample consisted of two main age groups, both from Stamford University and both sub-divided according to the students' stated vocational preference. The older group, of college Seniors, were first tested in 1927 and re-tested in 1932, 1937 and 1949, whilst the dates of testing for the younger group, of College Freshmen, were 1930, 1931, 1939 and 1949. The size of the sub-groups ranged from 50 to 228.

He found that similarities in the order of the individual items in a list of interests remained very high even over many years. The results were expressed numerically in such a way that if the list of vocational preferences given at the beginning of a certain period of time remains unchanged at the end of that period the coefficient is 1.0, whilst if the second list bears no relation to the first it will be 0.0. By using this method Strong found that over a period of five years he obtained a coefficient of 0.84 and that this declined only to the extent of becoming 0.82 after ten years and 0.75 after twenty years. In another study of the vocational preferences of a group of 306 University engineering students he found that the correlation coefficient after one year was 0.91 and that this declined to 0.77 after nine years, but then only to 0.76 after a further ten years. Although the decline in the second study is greater than in the first it is still remarkably small.

The students who were tested in these two studies were relatively able and mature so Strong also tested the popularly-held assumption that the vocational interests held by younger people are less stable than those of older groups. Although the evidence justified this assumption to a certain extent the interests did not fluctuate to the same degree as reported by the earlier work of Fryer. Thus, the degree of permanence found for the interests of seventeen-year-old boys over a period of between two and three years was found to be 0.81 and for College Freshmen over a period of nineteen years 0.72, both

being much higher than is often assumed. In general, he found that between the ages of 15 and 25 years with this group of people, one-third of the reported change in vocational interest occurs between the ages of 15+ and 16+ years, a further third between 16+ and 18+ and the last third between 18+ and 25+ years. After that age interests appear to become better established, unlike other phenomena such as memory, until about 55 years of age.

He concluded that the predictive value of interest measurements is influenced by the age at which the student is tested being greater with older than younger ones. Most secondary school children in this country have to decide what jobs to take at the age of 15 years when they can legally leave full-time education, and most of their vocational guidance is given before this age. It will be valuable, therefore, to consider later whether Strong's conclusion is applicable to British conditions.

Concerning the number, or span, of interests and its relationships with ability, Strong was able to add confirmatory evidence to Fryer's work. As previously mentioned, his Vocational Interest Blank can give patterns of interests for many occupations. By giving 34 of these occupational scales to a group of American engineering graduates he calculated that each graduate would achieve an average of three " A's," that is, each would show a strong interest in three occupations. In fact, he found that the average span for each graduate was 4.8 and put forward the view that high ability was the most likely cause for this result. Thus, although the level of ability may not affect the type, or quality of interests, it may very well affect the number of interests held by individuals.

Strong concludes that the scores obtained by his inventory are nearly comparable in their degree of permanence over a period of ten to twenty years to those derived from verbal ability tests. Much more evidence is needed before this can be finally accepted although the use of inventoried vocational interests with this type of student does appear to be justified in educational and vocational guidance procedures. However, caution is necessary in the use of this technique for predictive purposes. The inventoried interests of these students over-lap to a considerable extent, as is shown by the spread of the span of interests quoted above. A vocational term such as " engineer " is wide and such an occupation is also closely similar to others. In giving advice it would be difficult to predict success in any one specific job although the above results indicate that it is possible to give advice to a candidate on the basis of his vocational interest pattern as to his suitability in a fairly broad field of occupations. As an example of this conclusion Strong found with his group of 306 Stanford University Freshmen that the relationship between engineering and physical science scores was very strong but that this interrelationship weakened progressively with the scores of biological sciences, business studies, social sciences, law and languages. Thus, there were 82 chances in 100 that if a student scored an "A" in engineering interests he would graduate at least in some physical *or* biological science; it would be much more difficult to predict graduation in more circumscribed engineering studies depending upon the degree of specificity.

(*c*) *The Kuder Preference Record*

Strong's technique and evidence are very valuable although, because of its disadvantages, his test is not widely used in Europe. An American test which has found more favour as a model is the *Kuder Preference Record.*

Unlike Strong's items the interest stimuli in the Kuder test are only presented in the form of activities such as "painting china" and "selling vacuum cleaners." The "forced-choice" principle is used in answering the items in which three activities are listed. In answering each of the 168 items the candidate must indicate the activity stimuli which he most and least prefers.

Another difference with Strong's inventory, which is constructed upon *a posteriori* grounds by grouping the test items only after they have been given to the occupational groups, is that the Kuder inventory arranges its items upon *a priori* considerations. Thus, it was assumed, and later proved to be valid, that there existed ten main categories of interest reactions: outdoor, mechanical, computational, scientific, persuasive, artistic, literary, musical, social service and clerical.

As the Kuder inventory takes less time to administer and score—it can be done by hand even in large-scale applications—and because the content is less extensive and less likely to offend respondents it has appealed more to European research workers. However, a warning given by the Atkinson committee should be noted. This was a Canadian study which assessed the value of the instrument for the purposes of giving individual students advice about the type of course they should take upon entrance to the university. The predictive value of this test was found to be low, mainly because of the great overlap which occurred between the interests of students of different subjects, although the committee admitted that more evidence was needed before this finding could be accepted as conclusive and that it did not invalidate the instrument's use for other purposes of vocational guidance and research.

(*d*) *The role of interests in theories of Vocational Development*

Finally, some American research workers have attempted to place in perspective the role which an individual's vocational interests play in the stages through which he passes from the time when he first expresses a vague liking for a certain career to the final acceptance of a job. Ginzberg considers that occupational choice is a process of continuous development over a period of about ten years. It ends in a compromise between the influence of interests, abilities, a scale of values concerning job attributes such as pay and pensions, and the employment opportunities available. Once completed it is largely irreversible because of the investments of time, money and the disinclination of an individual to change his ways of life. Within this period of development he distinguishes three main phases, the earliest being that of the child's choice, essentially one of fantasy, governed largely by the wish to imitate adults. This is later superseded by the young adolescent's rather more realistic, but still tentative, choice of a career which is at first determined by interest but later largely replaced by considerations of personal abilities, skills and the relative advantages and disadvantages of particular jobs. Finally, at the school leaving age there is a period of realistic choice when alternative occupations are finally considered and a specific job chosen.

Super considers that the special contribution of this theory lies in the hypothesis of the successive dominance of interests, abilities and job attributes as determinants of choice before reality begins to play a major role. However, he finds four main faults: that it does not build sufficiently upon other research data—and in particular that derived

from studies of the predictive value of inventoried interests; that choice is defined as a passive preference rather than as an active decision to enter a job which will influence the age at which reality plays an important part; that there is a false distinction made between the terms " choice " and " adjustment " whereas in fact they blend; and that there is little consideration of how the compromise is made between Ginzberg's variables of interests, abilities, job attributes and opportunities.

This last point Super considers to be crucial to the whole problem and analyses it in detail. Individuals vary considerably in their interests, abilities and personalities and are qualified by virtue of these characteristics to succeed in a number of occupations, as Strong found. As occupations also have overlapping, patterns of these characteristics not only has each person a choice of jobs but within each job will be found persons of slightly different characteristics. The blending of the two patterns, resulting in occupational success and individual satisfaction, is again seen as a continuous process of five main stages: growth; exploration, in which fantasy is succeeded by tentative and then more realistic choices; and then a period in which the choices are established through the phases of trial and error before finally becoming stable. This stability is then maintained during the adult life until it eventually declines with age.

2. Research Evidence from other Countries

Most countries with complex industrial structures have vocational guidance problems which are similar to those studied by the American research workers. At the end of every academic session there are many thousands of secondary school leavers possessing different patterns of interests and abilities seeking to enter careers and courses of further education which require different levels of skill and educational achievement. To adjust the needs of the one to the other is a task of great difficulty which some countries have sought to resolve by using data and adapting techniques derived from American sources for local conditions.

(*a*) *Australia*

Perhaps of wide application to the school-leavers of the United Kingdom is the data derived from the development of an Australian interest test. This investigation attempted to assess secondary school pupils' vocational preferences in Tasmania by the use of the Rothwell-Miller Vocational Interest Blank which lists occupations suitable for both boys and girls.

The occupations are grouped on *a priori* grounds, as is the Kuder inventory, on the statistically tested assumption that there are twelve distinct patterns of occupational interest. These are outdoor, mechanical, computational, scientific, personal contact, aesthetic, literary, musical, social service, clerical, practical and medical. The list is divided into groups so that they include one example from each of the 12 patterns of occupational interest. The pupil is asked to grade the occupations in each group from 1 to 12 in descending order of interest and from this it is a simple process to analyse the particular occupational preferences of the children.

This inventory has been used with groups aged from 12 years to adult, including secondary school pupils, college students and adults actually pursuing their vocations. The results support Strong's contention that most change in vocational interests occurs before the age of 18 years, this being more marked with younger age groups than with the older ones, and Rothwell advises that the inventory should be used mainly with children of 13 years and older.

Investigating the types of changes which occur, Weeks, using this test, also with Australian children, is reported to have found significant changes in the order of the preferred occupations between different age groups. Most change occurs in the middle of the list of preferences with the first two or three strong likes and dislikes remaining relatively stable. However, even here changes occur. He administered the inventory to groups of private secondary school pupils in one boys' and one girls' school. Between the ages of 11 and 16 years, girls changed their preferences from Clerical and Mechanical towards Medical and Scientific types, while boys preferred Computational and Scientific to Practical and Mechanical, although the latter regained some of its popularity at 17 years of age.

However, in many European countries the task of allocating children to different types of secondary schools is added to that of giving vocational advice to the older pupils. In fact, allocation at eleven or even at thirteen is itself a form of premature vocational guidance for the range of occupations which are available to the pupils of different types of secondary schools is limited by the level and type of syllabus and examinations which are provided. This problem has become steadily more acute as a result of the widespread post-war reforms in educational organisation. In many countries, for example, Belgium, France, Germany, Holland, Italy and the United Kingdom, techniques were developed to measure the interests of younger pupils, mainly of 11 to 13 years of age, for the purpose of selecting or guiding them to suitable courses of secondary education. Generally, the Kuder method was preferred to that of Strong and psychologists such as Irle in Germany and Chaudagne in France have developed tests of their own based upon his technique.

(*b*) *Holland*

A Dutch study is of particular value to educational advisers in this country because of its comprehensive nature and the close similarity to our own of the types of schools in which it was conducted.

In Holland most pupils enter one of four main types of secondary schools when they are 12 years old, after having had six years of primary school eductaion. The four types available are grammar schools, preparing pupils mainly for university entrance; " extension " schools which give a preparation for entrance to vocational training colleges and for clerical and commercial work; " trade " schools, which combine a " general " education with pre-vocational training for skilled trades; and " junior " secondary schools which give a " general " education at a comparatively simple level together with some manual training. Generally, pupils of the last type are prepared for semi- and unskilled work, although some enter apprenticeships. Of the pupils transferring from primary to secondary schools, about 15%, 30%, 40% and 10% go to these four types respectively. One important difference from our own system is that children in the

primary schools are not promoted automatically from one form to another at the end of each academic year but are only promoted by merit, those of a poor standard being required to repeat the whole of a year's course. Thus, whereas the ages of pupils in British classes may vary only by a few months, in Holland the same grade may include pupils whose ages vary by one year or more.

A representative group of children was chosen for testing which included 478 girls and 531 boys who were in their last year of the primary school. The schools were chosen at random from a directory and the tests were administered at the end of the last primary school year when they had already been allocated to their different types of secondary schools. Two related problems were selected for investigation: that of isolating interest patterns which differentiated between the groups of children going to different types of secondary schools, and that of using interest measures to predict success in the chosen school courses and thus to reduce the number of misfits and failures.

The instrument used in the investigation was a Dutch adaptation of a vocational interest test originally developed in Germany by Irle. It includes 162 items which are grouped in the Kuder method. In each item four activities belonging to different interest patterns are compared, the pupil marking the one most strongly preferred. By means of this test the pupils' strength of interest is shown in vocational interest patterns and at two educational levels—educational and social work; applied art; literature and history; catering; a lower educational level; an upper educational level; agriculture and forestry; clerical and computational work; " persuasion " (in all kinds of commercial work); scientific and engineering; and mechanical. The upper and lower educational levels are characteristic of pupils in upper and lower school streams respectively.

When the test results were analysed important differences were noticed in the type of educational activities which interested boys and girls. The sequence of interest patterns given in the preceding paragraph represents the decreasing order of preferences of girls but the increasing order as marked by boys (reading left to right). The differences were particularly pronounced with the first three and the last three patterns, a result which supports, although it does not explain, the popular assumption that girls are more interested than boys in educational and social work, art, literature and history, whilst boys are more interested than girls in mechanical and scientific studies, engineering, and in salesmanship.

The data derived from the first part of the investigation does indeed suggest that the interest patterns derived from each of the four secondary school destination groups are distinctive. If the scientific and literary patterns are accepted as measuring intellectual interests, and the catering, industrial and agricultural patterns as being mainly manual in character the sequence of school types which describes a decreasing liking for intellectual activities and an increasing liking for manual activities on the part of the children going to them is grammar, " extension," " trade " and " junior."

There are, of course, interesting deviations from this general sequence. Apparently, grammar school girls like quite strongly the agricultural pattern of interests which is, of course, essentially manual in character. This interest may be created by the widespread popularity of gardening amongst mothers of " middle-class " background. In fact, this may give a clue to the relationship between the above sequence of interest

patterns and types of schools. The home background exerts a considerable influence upon a child's school performance and probably also upon his or her pattern of interests, particularly when such educational and vocational patterns are emerging at about this age. Children from homes which provide a rich variety of intellectually interesting stimuli may very well be expected to score highly on the appropriate intellectual interest pattern. Similarly, if the level of educational and vocational aspiration is high and the children are encouraged to go to university rather than leave school as soon as possible it is not difficult to imagine a situation in which they will turn away from the semi- and unskilled manual occupations characteristic of early school leavers.

This evidence supports the contention that distinct educational interest patterns exist even as early as the end of the primary school career but it still remains to show whether interest scores can predict success in the secondary school. To do this a " follow-up " study was conducted of boys and girls who went to grammar schools. The test scores which were obtained at the end of the last year of the primary school were compared with the examination results at the end of the first year in the grammar schools. During this year all the children concerned received a similar course of education although they attended different schools. However, the school policy concerning why and how children should be promoted from the first to the second year courses differed. Some schools preferred to set an easy examination and to give the children more time to settle into the new school environment whilst others set a harder examination to allow only those who had a good chance of entering the universities to pass the next grade. Failures then could be guided to other types of school more suited to their level of ability as soon as possible. The prognostic value of the interest scores, it might be expected, would be more readily assessed when compared with the results of a difficult examination, success in which might only be expected from a combination of high ability and strongly-developed interest. Hence, a comparison was made between the interests scores of those who passed difficult school examinations and those who had failed both easy and hard ones. Because of the lapse of time necessary to get complete results only the first year ones were taken as a criterion of success for the purposes of prediction. This may, of course, mean that some of the children who passed this examination would fail subsequently.

Even within this modest and short-range criterion, there is a clear distinction between the successful and unsuccessful groups. The successful group shows a distinctive pattern of interest: high intellectual interest scores, a high performance on the " upper level " scale and a low one on the " lower level " scale; whilst the " failure " group scored highly on occupational patterns such as applied art, catering and agriculture. In particular, with girls the " persuasive " pattern was highly discriminating; only 10% of the successful group had scores on this pattern of over 40, compared with 70% in the " failure " group. A prediction of success thus appears to be possible, at least in the first grammar school year, for those children who exhibited to a marked degree the patterns of interests found to be typical of those last-year primary school children who are transferring to grammar schools.

This result is similar to that found in a study of Swedish students who were also of high ability and it might appear, therefore, that prediction of academic success based upon interest measurements, both at the beginning of the grammar school and university

careers, may be strongly influenced by high ability. However, this does not seem to be the case because the correlation between interest and ability scores was found to be slight and the former appear to have a predictive value of their own.

This agrees with Fryer's conclusion, but it leads to an apparent and unresolved paradox. It has already been noted that whilst ability and interest test scores are unrelated, ability appears to affect the range and variety of the children's personal interests. An important aspect of the Dutch study supports this conclusion and adds a new element to it. The normal relationship between school type and interest pattern which has been described, of grammar school and " intellectual " interests on the one hand and trade courses and " trade " interests on the other, apparently holds good for children even of the poorest ability. However, when these least and most able groups are studied more closely, it is clear that the least able have a smaller span and less variety of interests than their more able contemporaries. Even sex differences of interest patterns, which are important with the more able children, dwindle in significance; in the case of the boys, for example, deviations from the average pattern in nine cases out of ten occurred in the direction of the interest patterns of girls of similar ability rather than of boys of higher ability.

The connection between the home background and the quality of childrens' interests, already noted in the case of the grammar school girls, is reinforced by this evidence concerning their less able contemporaries. Homes differ in the quality and range of the interest stimuli which they offer their children, some being biased towards intellectual pursuits, some encouraging more manual activities, whilst, at the lowest level, are those in which there is very little to stimulate children at all. Attention has already been drawn to the need to give older pupils a greater range of knowledge and experience upon which they can draw when choosing a career. Apparently there is also a need at an earlier age for the schools to foster a variety of interests, intellectual, physical and moral, in all types of schools and at all levels of ability.

3. Research Evidence from the United Kingdom

The evidence from America and Europe indicates that it is possible to isolate patterns of vocational and educational interests and that measured interests are much more stable than has been popularly assumed even at the beginning of the secondary school career. It would appear to be possible, therefore, to use interest scores for the purpose of predicting success in careers and courses of education within broad limits. However, in the American reports was presented a plea for the provision of greater information about careers whilst those from Europe indicate that variety rather than specialisation should characterise the syllabus of secondary schools. It now remains to see whether these conclusions, and the techniques from which they are derived, are applicable to British conditions.

(*a*) *Components of the guidance procedure*

The mobilisation of great numbers of men and women for war-time work concentrated the attention of research workers upon the techniques of guidance and selection. Although the problem was essentially vocational in nature the work holds important implications for educational advisers.

One of the main summaries of this work is that of Vernon and Parry who used measurements of interest as well as of general and special abilities and skills in their selection procedures. In their work the authors used interviews, questionnaires, inventories and tests and assessed the place these components should be given in the selection scheme.

They found evidence which confirmed Fryer's conclusion that little reliance could be placed upon the interview for the purpose of selection. In a later report Vernon summarised the evidence of other research workers which supported this view in the illustration that if two interviewers working independently are asked to select 20 candidates for a grammar school from 100 applicants on their judgment alone they will agree only on 9 and will disagree on 11.

The two authors considered, however, that the interview could form an important component of guidance if certain precautions were taken. The interviewer should be experienced in his work and should be provided with full information about the tasks sought by the candidates. This should cover the physical and social aspects of the work as well as the operations to be performed in undertaking it and should involve as little use as possible of generalised characteristics such as " concentration " and " dexgerity." If traits such as these can be clearly defined they are better tested objectively, leaving the interviewer to assess personal traits not so readily covered by tests. The interview should be used to gain a clear picture of the candidate which is essential for a complete and true interpretation of data derived from isolated tests and questionnaires.

Vernon and Parry found that the usefulness of questionnaires was limited by the differences in candidates' judgments of what information is relevant and important. When asked to mark a list of activities which they had performed some candidates ticked nearly every item whilst others marked only those activities on which they had spent a lot of time or in which they had performed well. More objective measures were found to be necessary.

They considered the Strong and Kuder inventories to be of use both methodologically and in the conclusions reported. A test of the Strong type was developed and found to be a valuable instrument, but because of the difficulty of scoring and analysis it was not used on a large scale. It was also found to be of less value in the assessment of the leisure-time interests of less able adults than of their more able contemporaries. The leisure interests of a skilled instrument mechanic might resemble more closely those of an equally intelligent clerk rather than those of a less able worker in his own craft, and accordingly a satisfactory allocation using this criterion would be impossible.

Information tests were also used to select personnel for " practical " tasks. In one example, two such tests, of electrical and mechanical information, were given to groups of 300 naval radio mechanic trainees, 214 electrical mechanics and about 100 wiremen. Compared with other tests used, mainly of special ability and skill, the instruments appeared to be quite useful for when they are compared with the end-of-course result correlations were found to be 0.46, 0.46 and 0.36 respectively. In another scheme mechanical ability and interest tests were given to a group of 300 boys training to be fitters, armourers, masons, carpenters, electricians and instrument makers. Again it was found that interest tests of the Strong type, were useful supplements to the information provided by the ability scores.

The authors report with approval the advice given by Wilson about the value of interest measures in guidance procedures. He found that the relevant aspects of interests which should be covered by interviews, tests and questionnaires are their range, span, depth, stability, relationship with the proposed task, origin (to assess their permanence), and the degree to which the various interests reinforce or conflict with each other. He also found that the strength with which the interests were pursued was of great importance.

(*b*) *Factors Influencing Vocational Preferences*

Although much less relevant work has been done here than in the United States, the volume of work in Britain (in common with other European countries), has increased considerably since the end of the second world war. Again, recent conclusions tend to be more optimistic than earlier ones. Fryer's caution was supported in 1938 by Rodgers who, as a result of his work in giving vocational guidance to groups of secondary school pupils of both sexes found little evidence to justify the undue importance which parents and teachers attached to children's statements of interests. Stott confirms this conclusion. Over a period of fifteen years prior to 1941 she gave vocational guidance to over 1,900 girls and 600 boys, most of whom attended secondary schools, presumably of a selective nature, and were between the ages of 16 and 19 years.

It is reasonable to expect that by reason of ability, age and background these children should be realistic and well informed about their vocational preferences, but this was not evident in their statements. Girls were particularly unrealistic in their choice of a career, often striving to enter an occupation to succeed in which they themselves realised that they had neither the ability nor the qualifications. They also expected to reach high positions quickly and appreciated far less even than did boys that this was only possible after a long, arduous and often tedious training.

Both the writers attributed this to inadequate vocational information on the part of both children and parents. Stott in particular noted the great influence which the opinions of parents had upon the choices of their children. Sometimes these took the form of encouraging sons to choose jobs for which they were not suited and in which they had no real interest, and daughters to accept jobs which were well below their ability.

It is important to consider this problem further and in particular to study the factors which appear to be influential in disposing children to choose certain occupations from the comparatively wide range which is open to most of them and to assess the adequacy of secondary school children's knowledge about careers.

At about the same time as Stott's study, Lingwood investigated the adequacy and realism of the vocational information which was possessed by selective secondary school girls. For this purpose she took groups of 40 to 60 children in each age group from 13 to 16 years. A course of four careers lectures was given at the end of which girls were encouraged to ask questions about occupations. Before and after the course a questionnaire was administered in which the girls were asked to record the jobs which they liked best and to mark from a list the reasons for their choice, a procedure in which the advice of Valentine and Ritchie was followed. The information was checked for correctness of knowledge about preliminary qualifications, employment conditions and the nature of the chosen work.

Generally, younger girls were found to make wider but more fanciful choices and also appeared to absorb less information about careers than the older pupils. From the third year onwards the amount of detail which they could learn increased and there appeared to be a marked improvement in the correctness of their vocational knowledge. At the same time they abandoned the more fanciful careers as serious preferences.

The influence of the home upon their choice was strong and all girls accepted to some degree the advice of their parents. The school environment also emerged as an important factor in many ways. Many pupils wanted to become teachers, perhaps because it was the only career with which they had had a close contact, whilst others, who stated a preference for commerce and nursing were possibly influenced by school tradition, for many " old girls " had entered these occupations upon leaving school. Lack of ability was rarely mentioned as a barrier to entering a job but the expense of long periods of training discouraged many from choosing careers where this was necessary.

This research data supports popular opinion in pointing to the home and school environments as being the most important sources of interest stimuli affecting the vocational choice of secondary school children in this country. Perhaps of greater value to advisers will be studies of the manner in which choice is influenced by these agents.

Among the post-war investigations, one conducted by Jahoda in 1952 is important. He interviewed and gave a questionnaire to 56 boys and 77 girls in two secondary modern schools in an industrial district. Afterwards, he conducted a " follow-up " study with them once they had entered their first jobs. The home appeared as the most important influence but there occurred also significant differences in the attitudes of the parents to the vocational preferences of their children. Mothers were preoccupied with the careers of all their children, although their main influence was exerted upon their daughter's choice; on the other hand, fathers tended to help only their sons. Most parents appeared to be very tolerant and rarely tried to impose their views upon their children; when they did so it was mainly to warn against disadvantages rather than to point out advantages. Many did not give formal advice, although even with these their informal attitudes affected the choices which the children made.

The advice of parents was sometimes strongly supplemented by that of adult friends of the family and by contemporaries of the children who had recently left school to begin work. Hobbies, part-time jobs and other home factors were rarely mentioned as determinants of vocational choice by the children although much is sometimes built upon statements of these for the purposes of giving guidance.

Again, it was found that the school as an agent was next in importance to the home. The influence of the teachers appeared to be more subtle than direct and was greatest as the end of the school course approached. More outstanding was a liking or disliking for school subjects. The best-liked subjects, and therefore the most influential, for the boys were woodwork, metalwork and practical drawing, and for girls needlework, cooking and baking. Subjects such as English and Arithmetic were mentioned mainly because they limited choice; thus, poor spelling was considered to be a barrier to becoming a good secretary.

Visits to factories apparently were of little value in helping the children to choose careers. This may have been the result of having too few visits (on an average only 0.3 for boys and 1.1 for girls during the last year at school) and perhaps of poor planning whereby the visits took place after the children had chosen their careers.

The value and influence of the Youth Employment Officer's talks were also studied. These talks were given at the beginning of the penultimate term and were carefully organised. Of the children who attended, 46 per cent. of the boys and 52 per cent. of the girls mentioned them in their questionnaires as being a contributary factor to their occupational choice. Apparently the main value lay in widening the occupational horizon, discouraging unrealistic choices, focussing attention upon the main considerations by the pupil and parent and thereafter helping to narrow the choice from a general area to a specific job. Those who were not influenced had already chosen their careers. However, only 20 per cent. of the final jobs were accepted as the exclusive result of the Officer's advice. When the children's vocational knowledge was studied 20 per cent. were found to be well informed compared with 40 per cent. who knew little beyond the name of the job.

In general, there was no evidence that any two types of influences are associated although each child was, on average, influenced by between two and three factors, of which the order of importance appears to be parents, contemporaries and school activities.

One reason which may be advanced for Jahoda's conclusions is that the investigation was conducted in one particular type of school. However, two further studies by McGiffin in 1958 and Chown in 1959 found similar conditions obtaining in secondary grammar and technical schools of both sexes.

The first research worker gave a questionnaire to 254 fifth and sixth formers in two boys' Belfast grammar schools. He found that 197 had already chosen their careers and in general the choices appeared to be realistic when compared with their measured ability. When their vocational knowledge was assessed it appeared that although they had adequate general information about their immediate career only 18 per cent. were well informed about the working conditions of their chosen jobs compared with the 59 per cent. who were poorly informed.

The most popular occupations among the boys were: engineering, teaching, scientific work, medicine, the Armed Forces, agriculture, and the Church; whilst the most frequent reasons for their choice were recorded as being: an interest in the job, a good performance in the relevant school subjects, security of tenure and good prospects of promotion, an interest in " people " and good pay and hours of work. These choices, and the reasons for making them, appeared to be affected by three main agents of which the home was again the most powerful, especially when it actively encouraged the boys to take an interest in their future careers. This took the form of suggestions that the boys read books on careers and seek the advice of adult relatives and friends for details of their occupations and had the effect of widening their vocational horizons.

The agent next in importance was the school. Most of the choices had been made when the pupils were between 13 and 18 years of age, but the most popular time for making firm decisions was just before the secondary school external examination was taken at 15 years. It also exerted a more subtle influence in concert with the third factor,

the opportunities for employment available in the locality. As was found in the last study the list of jobs preferred by the boys—and perhaps also the reasons for choosing them—are typical of those traditionally associated with grammar schools and regions of heavy industry.

Chown gave a questionnaire to 192 boys and girls who were attending four secondary grammar schools in different residential districts and also interviewed the parents as well as the children. When analysed this data was compared with three other sets of results: of Jahoda, derived from a study of secondary " modern " school children; of a group of children whose vocational knowledge was assessed in 1927 for its amount and accuracy; and the applicability of Ginzberg's theory of vocational development to British conditions.

The results of this investigation showed that Ginzberg's theory was applicable to the conditions of a British grammar school only in a very modified form, and that compared with the earlier group there had been little improvement in the amount of vocational knowledge which was possessed by the children. When compared with Jahoda's conclusions, however, differences were noticed. Although the home and school were still the two most influential factors on the pupil's choice of careers there was a subtle change in the balance of power. Chown's children were less influenced by parents, relatives, friends and out-of-school activities in general whilst the part played by teachers and performance in relevant school subjects were correspondingly greater. Girls in particular were active in seeking vocational advice from teachers. Perhaps this is caused by the parents' inability to give information about careers of an advanced technical nature which is beyond their range of experience.

Sex differences in vocational choice have been noted by several of the above writers and it may be of value to assess the research evidence about one explanation which is often given. The choice of a girl's career is generally considered to be strongly influenced by her hopes of marriage. Stott found that because of this expectation parents often treated the aspirations of daughters with less seriousness than that of sons. In part she considers that this attitude of the parents encourages girls to choose rather fanciful jobs, in which they expect rapid promotion, often as a result of turning to women's magazines as sources of information. It may also help to explain the reason why girls are willing to choose the jobs of their more favoured brothers whilst boys rarely prefer those traditionally associated with women.

More factual evidence comes from a recent study by Gallagher who gave a questionnaire to a group of 190 girls who were leaving the secondary technical and grammar schools of Wallasey. A " follow-up " study of some of the girls was also made.

Of this group, 50 per cent. were married or engaged within six years of leaving school whilst nearly all hoped for this to happen before becoming 28 years old. It is not surprising, therefore, that 74 per cent. left school before they had completed a sixth form course. This represents a considerable loss of talent for the community and of valuable experience to the girls. Although the school-leavers realised this and were often dissatisfied with their jobs few were willing to seek advancement through further study for more than one-third considered further vocational training to be of no value to women and less than 50 per cent. accepted jobs which required it. In general, 75 per cent. of

the group intended to leave work when they married and of the 67 per cent. who were found to be ambitious only 22 per cent. had taken constructive measures to further their aspirations.

(*c*) *Educational Guidance*

Much of the war-time work on measurement techniques was conducted with older people and was mainly vocational in character. In recent years tests which are simple to administer and efficient have been developed in this country for use in schools. Although originally developed for the 11-year-old age groups they have also been used successfully with older children and could form a valuable component for guidance within the school when, for example, children are guided to different specialist courses at the age of 13 years.

Fleming has developed a test (P.A.I.) designed to assess the preferences of school children for objects, ideas or people which has been used to guide children to courses with technical and other types of bias. The items are presented in the form of statements which are grouped under the following nine headings: " Knowing your own mind," " Talking about wishes," " Judging other people," " Choosing Work," " Spending Money," " Using one's hands," " Being with other people," and " Talking about School." Taking each section separately the children are asked to mark four statements which vary from the one considered to be most sensible to the one with which there is no agreement. The last section is entitled " Keeping a Record " and lists forty activities on which children have been found to spend time. The respondent is asked to mark those activities which have been undertaken in the previous fortnight together with those which the child would like to have done.

Another frequently-used test in this country is the Wiseman-Fitzpatrick " Devon " Interest Test, separately developed for boys and girls and yielding both " practical " and " academic " scores. The respondents are asked to read groups of six activities mainly related to their everyday life, and to indicate whether these activities are liked, disliked, not undertaken or unknown. In addition, the first and second strongest " likes " are recorded. In each panel of six activities there is a strong " distractor," for example, " playing football " or " going to see an exciting film." This was found to be highly discriminating and especially indicated pupils with a " practical " bias strong enough to take precedence over the " distracting " activity.

Lambert and Peel have also developed a test to distinguish between children who would be best advised to opt for either a broadly academic or technical curriculum. In form it is an information test which is divided into three main sections. The first makes use of the multiple choice response whilst the second is an " open " word association test. On these two parts the pupil is asked to choose between " academic " and " practical " items known by previous statistical analysis to be of equal difficulty. In the third section the pupil has no choice and is required to answer both " practical " and " academic " items. Hence the first two sections give measures of bias towards either " practical " or " academic " interests whilst the third section assesses the level of interest in terms of actual knowledge of types both of pursuit.

By the use of the last two instruments valuable evidence has thus been reported about the development of boys' and girls' interest in " practical " and " academic " studies.

The Lambert-Peel General Information Test, together with tests of practical and academic ability and attainment, were administered to the top 30 per cent. of ability of the 11+ year age group throughout the county of Northumberland. The total sample numbered 481 boys drawn from rural, urban and industrial areas. The original test data showed that the bias of interest on the part of the whole group was towards an academic curriculum. When 103 were re-tested after one year in their secondary schools and a similar group was tested after yet another year it was found that this academic bias had changed significantly towards the technical curriculum. This change took place at all levels of original interest and in both grammar and secondary modern schools.

No statistically significant difference was found between the mean scores of the rural, urban and industrial groups. However, there was one interesting and highly significant result. The scores of the children from industrial areas reflected the fact that they had acquired technical information from their environment to the same extent as academic information (as shown by their responses to the third part of the test), although in fact their replies to the first two parts showed that many of them still did not choose practical to the same extent as academic items when given the choice.

Sometimes the suggestion is made that able children, as measured by tests of verbal ability, are better served by an academically biased curriculum. The scatter of interests throughout the whole range of this top 30 per cent. of ability does not justify this assumption. In general, there was a marked degree of individual difference noticeable in both practical and verbal ability scores and measures of interest, the I.Q.'s ranging from 144 to 108 and the bias of interest varying from —83 to +41, where the total possible, academic and practical, scores are —100 and +100 respectively.

Finally, the relationship between success in various school subjects and the practical scores was studied. No technical schools were provided in the county and because of their numbers secondary modern schools only received small groups of the children included in the sample so that the study took place in three grammar schools, one being drawn from each of the three areas noted above. A measure of the children's attainment in school subjects was obtained by means of a conversion chart prepared by the Local Education Authority to standardise the marks of the different schools and teachers. Taking six subjects taught at this junior level it was found, as might well be expected, that the subjects which showed the closest relationship with the practical score was woodwork and, in decreasing order, art, science, mathematics, English and French. These results can only be tentative as the total number of children involved in this part of the study was only 60; however, it points the way for further study with larger samples in other types of schools and with older pupils.

In the research programme of the National Foundation for Educational Research problems of educational guidance are being studied at the secondary school and technical college level. In 1954 a " pilot " study began with groups of 42 boys and 52 girls drawn from two single sex technical schools in an industrial town. Batteries of tests were given to the children when they first entered the school at 11 years of age and two years later.

Both batteries included tests of general and special abilities as well as the Lambert-Peel General Information Test and the Wiseman-Fitzpatrick " Devon " Interest Test.

When compared with teachers' assessments of performance in class subjects taken in 1958 neither of the two interest tests given at either administration appeared to have significant predictive value, the one coming nearest to significance being the practical score of the General Information Test. However, it should be pointed out that the samples are small and that teachers' assessments are probably too subjective to provide a valid criterion by which the scores of objective tests can be judged.

N.F.E.R. Interest Test Scores (Means and Standard Deviations)

Test	Year	Boys (N=41)		Girls (N=55)	
		Mean	S.D.	Mean	S.D.
General Information:					
Practical	1954	8.29	3.72	3.96	2.19
Academic	1954	13.02	3.43	12.75	3.03
Practical	1956	15.59	5.84	5.13	2.04
Academic	1956	16.63	4.28	17.27	3.63
" Devon ":					
Practical	1954	18.34	11.08	16.36	7.06
Academic	1954	8.59	5.90	8.55	6.58
Practical	1956	15.61	10.10	13.75	6.28
Academic	1956	8.61	4.93	8.27	5.70

Source: N.F.E.R.

Of greater value is the data which is derived from a comparison of the average, or mean, scores for each test and sex. Measured by the General Information Test at 11 years of age the mean scores on the academic items are higher than those on the practical items for both boys and girls. On the " Devon " Interest Test, however, the opposite result was obtained. Probably this reflects the different purposes of the tests: the first measures interests by the amount of knowledge and the second records the likes or dislikes of children for certain activities. It is not surprising to discover that children prefer practical to academic activities at this age, nor is it unexpected to find that their academic knowledge is greater than their practical information since the influence of the primary school is often mainly academic and strong at this age.

The discovery that 11-year-old boys have greater " practical " information than the girls is not unexpected, particularly when the nature of the test items is considered. The practical items are derived from simple crafts and sciences such as woodwork, mechanics and electricity which are more associated with boys' than with girls' leisure time activities. In fact, the test probably reflects the change of emphasis in technical education at the secondary school level from a narrow trade training for boys to a broader, vocational education equally suitable for girls. On the other hand it is intriguing to note that on the " Devon " test girls expressed as strong a liking as boys for practical activities and preferred them to academic pursuits.

Two years later, at 13 years of age, the level of the mean academic and practical scores for both sexes has increased. There is very little difference between them on the academic scores but the gap between the practical scores has widened considerably in the boys' favour. This gives support to the views expressed above about the influence of the test items. However, even at this age, girls still prefer practical to academic activities and this remains equally as strong as that of the boys.

The cause may, perhaps, be found in the technical content of their schools' curriculum although it should be borne in mind that it is often the practice in our secondary schools to give a " general " education during the first two years in which any bias towards technical studies is slight. It may also be the result of an efficient post-primary selection procedure whereby girls of permanent " practical " bias were successfully allocated to a secondary technical school despite the fact that the " 11 + " interest score did not predict later teachers' assessments.

It has already been noted that the Dutch report has pleaded for the provision in that country of a greater variety of courses for girls of below average ability and it is pertinent to ask whether this plea should not be extended to all girls in this country. Of course, much more evidence is needed before this conclusion can be accepted as being final. However, some important confirmatory evidence comes from another research study of the National Foundation.

This was undertaken at West Hatch, a selective secondary technical school which is in a mixed residential area. During their first year at school 95 boys and 105 girls were given tests of general and special ability as well as the Fleming P.A.I., " Devon " Interset and the General Information Tests. As the study has only begun recently only results from the last two of the interest tests are available for the 11+-year-old children.

On the " Devon " Interest test there was a definite bias towards practical activities which is significant for both boys and girls, and especially so for the boys who score much more highly. There is no significant difference between the two sexes on academic scores. On the General Information Test practical and academic scores have not been considered separately and only the general bias towards one or the other can be given. This shows that there is a great difference between the scores of the two sexes, with the girls biased very heavily towards the academic items whilst the information which boys appear to have gained from practical and academic sources appears to be balanced equally. This is in general agreement with the data derived from the Northumberland

study reported above although the West Hatch boys have not responded to the "academic" items as strongly.

To test the effects of differences of ability on the scores of the interest tests, the verbal ability scores of boys and girls were divided into three groups and the interest scores of the top and bottom thirds of ability were compared. No great deviation from the pattern described for the whole group appeared although the " Devon " practical score for boys of low ability appears to be higher than for those of high ability whilst on the General Information test there is a difference between boys of high and low ability, the former appearing to have gained more academic knowledge whilst the latter show no bias in either direction.

Conclusion

Formerly, opinion has been sharply divided between those who hold that interests only affect personal satisfaction and others, often teachers and parents, who have placed too much reliance upon expressions of interest. During the last generation the boundary zone between the two groups has been narrowed by the evidence which testifies to the existence of educational and occupational interest patterns and shows that the measured interests of adolescents are sufficiently permanent, depending upon their age, to be used for the purposes of secondary school and vocational guidance. For these tasks a few instruments have already been developed in this country, although more are needed. However, two strong warnings must be given. Measurements of interests must only form part of the guidance procedure supplementing but not replacing, for example, tests of general and special abilities. Also it is important to accept the measured bias of a child's interest only as a general disposition to choose to study or enter a group of educational courses and careers, because interest as exhibited by the act of choice, may be greatly influenced by the wealth of information and other stimuli which exists in the home and school. In many cases it will be the task of the school to supplement the home's deficiency in this respect.

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THE EFFECTS OF STREAMING

by Alfred Yates and D. A. Pidgeon

IN the majority of large urban junior schools and in many secondary schools, children within the same age group are assigned at the beginning of the course to different classes according to their levels of general ability or of attainment in the basic subjects. This practice has been justified on the grounds that teachers can deal more effectively with relatively homogeneous groups of children than with those comprising pupils who manifest markedly different educational needs. Children of all levels, from the gifted to the dull, it is argued, benefit from an arrangement whereby for each class a rate of progress can be determined which is closely related to the pupils' capabilities.

A further—and necessary—justification for the practice of streaming is that, during the period of the junior school course, the relative levels of performance of the children remain fairly stable. Evidence has been obtained from a number of surveys which suggests that, in the main, primary school teachers believe that a coarse grouping of children into two or three categories is a feasible procedure. In other words, their experience has shown that, although some progressive re-ordering of the groups may be necessary, children can be satisfactorily allocated at or near the beginning of the course to groups that remain fairly homogeneous. In the majority of schools the streams are not equal in size. The general practice is to arrange small classes for the weakest pupils so that they can be given a considerable amount of individual attention.

Criticism of streaming

The practice of streaming in junior schools has recently been criticised, chiefly on the grounds that it may well result in a lowering of the morale and consequently of the achievements of those children who are assigned to the " C " streams. In a letter to the *Times Educational Supplement* (29th July, 1955), Mr. John C. Daniels, of the Nottingham University Institute of Education, stated that he had collected evidence to show that whilst children in the A stream of a junior school increased their measured I.Q's by an average of 7.4 points, those in the C stream decreased their average score by 12.3 points. Mr. Daniels, as far as we are aware, has not published the details of this investigation, nor of his subsequent inquiry, to which he referred in his letter, into the relative progress in attainments of pupils in different streams. Nevertheless, the suggestion that streaming may serve to perpetuate or even to intensify the initial differences on which it is based is now frequently made. The purpose of this brief note is to summarise the researches that have been undertaken into the effects of streaming in order to assess the validity of these criticisms.

The evidence of research

(*a*) *American investigations*

In discussing the findings of American investigations into the effectiveness of ability grouping, French writes: " While there are a few recent studies in this area much of the experimental work is more than twenty years old. This does not appear to mean that

the problem was settled twenty years ago, because the results of studies carried out in the twenties and thirties were conflicting. Different experimental designs, different tests, different teaching methods, and different learning materials all contributed to a confused situation."

French's own investigations, based on school records, did not serve to clarify the situation. He compared the achievements of classes grouped by ability with other more heterogeneous classes in the same high school. He found no significant relationship between achievement and the degree of homogeneity within the classes concerned. In other words, he found no evidence either in favour of or against the practice of streaming. He concludes his report by despairing of the possibility of resolving this issue by what is usually referred to as " operational " research (i.e. examining a situation as it exists—e.g. comparing streamed schools with unstreamed schools) on the grounds that in these circumstances it is impossible to ensure that appropriate teaching methods are being applied and with equal effectiveness, to all the groups of children concerned. He makes a plea, therefore, for " action " research, in which an experimental situation is contrived, allowing for the control of irrelevant variables and an adequate comparison between the progress and attainments of children who are streamed and those who are taught in randomly assorted groups.

Another example of American work in this field is the investigation of Breidenstine, who compared the educational quotients of children in four schools in which streaming was carried out with those in seven schools in which no such differentiation was made. He found little difference between the groups, although he reports a slight tendency for duller pupils to fare best in the streamed schools. Unfortunately, the design of this, and a number of other early investigations, does not provide an answer to some of the more pertinent questions that one would wish to ask. For example, it is relevant to discover not only the differences between the average levels of performance between streamed and unstreamed groups but also the differences between the variances or " spread " of the scores. This latter measure would indicate the extent to which streaming serves to widen the differences between the abilities and attainments of pupils, as some of its critics suggest that it does.

A survey of the experimental studies of homogeneous grouping in the United States has been provided by Ekstrom (1959). She reports thirteen studies favouring homogeneous grouping, fifteen reporting no differences in achievement in homogeneous or heterogeneous groups, or which found homogeneous grouping detrimental, and five studies which gave mixed results.

Not only is the research carried out in the United States inconclusive, but it is also concerned with a situation very different from that in our own schools. What has been investigated in the researches referred to above is the effects of grouping by ability within grades. Since the grade system involves the promotion of those who have reached a given standard and the repetition of grades by those who have failed to do so, this grouping by ability does not concern a single age group as in the schools in this country.

(*b*) *Research in the U.K.*

We have been able to discover only two sizeable investigations into the effects of streaming in this country.

Rudd studied the progress of two groups of eleven-year-old children in a London Central School. The experimental group consisted of ninety pupils divided into three streams on the basis of their performance in the eleven-plus examination. In accordance with the practice adopted in the school these children were regrouped after each half-yearly examination in order to ensure that the streaming was kept in line with the children's attainment.

The control group consisted of an equal number of children who were similarly divided into three groups when they entered the school but who were allowed to remain in the same classes throughout the first two years of the course. At the end of this period a considerable amount of regrouping took place amongst the children in this age group.

Tests of general ability and of attainment in arithmetic and English were given to all the children and comparisons made between the control and experimental groups and, within these groups, between those children who were transferred at some stage from one class to another and those who remained in their original class. Attempts were also made to measure the children's attitudes towards examinations and school work and to measure a number of personality variables.

The results of the tests of ability, attainments and attitudes revealed no significant differences between the groups. The author reports that " the samples of classroom behaviour revealed that where the organisation was based on streaming fewer social contributions to lessons were made by pupils, whilst there was more aggressive behaviour and less attention to work." These latter conclusions, however, were based on subjective assessments of the children's behaviour in the classroom.

This investigation suffered from a number of limitations. Only one school was involved and, moreover, the children concerned, having been selected for a central school on the basis of their scores in the eleven-plus examination, did not differ markedly in ability or attainment.* Furthermore, nothing in these circumstances could be done to control or to allow for differences in effectiveness between the teachers.

A more extensive investigation has been carried out by Blandford. This involved the analysis of the scores derived from tests administered to 1,700 pupils drawn from twenty-four primary schools in the area of a large county authority. The battery of tests comprised five tests of attainment and an intelligence test consisting of both verbal and non-verbal items. The tests were given on four occasions (parallel forms of the tests were used alternately) when the average ages of children were approximately 8, 9, 10 and 10¼.

A comparison was made between the results obtained in those schools which had three or more streams and another group in which the number of children in the age group concerned was just sufficient to form one class. Two hypotheses were examined. First it has been suggested that streaming tends to preserve the differences between pupils' rates of progress and levels of attainment. If this were so, one would expect to find that the correlations between the test scores near the beginning of the course and those a year or two later would be higher in streamed than in unstreamed schools. This was not borne out by the results of this investigation. Only one of the correlations

*The children selected for central schools in London at the time when this investigation was carried out were those who, in the examination list, came below the pupils who qualified for grammar school places, but higher than those allocated to modern schools. Thus, they all belonged to the " borderline " group.

reached a moderate level of significance and even this disappeared when due allowance was made for the fact that the spread of scores was smaller in the unstreamed than in the streamed schools.

The second hypothesis examined in this analysis was that the gap between children's levels of ability and attainment tends to be widened as a result of streaming. In order to test this hypothesis a comparison was made between the spread of scores in the streamed schools with that in the unstreamed schools. A highly significant difference was found in the case of the attainment scores, but the difference with respect to the scores in the intelligence test did not reach a statistically significant level. Thus, no support was found in this investigation for the conclusions reached by Daniels (see above).

Further evidence which may have a bearing on the effects of streaming has been provided in this Journal by Pidgeon. In reporting the results of a comparative survey of the attainments in reading and arithmetic of eleven-year-old children in England and Wales, Queensland, Australia, and Central California, Pidgeon shows that in all the tests administered the standard deviation or spread of the scores was significantly larger for the children in this country than for those in Queensland, where the grade placement system is employed. This investigation also revealed that in reading, not only was the mean score higher in England and Wales, but there were fewer " poor " readers. In arithmetic, however, although the mean scores were the same for the two countries, England and Wales produced more " poor " arithmeticians and there was other evidence to suggest that in this subject the Queensland children were superior. Thus, although this study supports the view that streaming may result in a widening of the gap between children's levels of performance, it offers no conclusive evidence that it results in either superior or inferior attainment.

The evidence from this comparative study must, however, be reviewed with caution. The comparison made was not between streaming as practised in this country and not streaming, which is the real issue we wish to investigate, but between the eduactional system practised in England and Wales, which includes streaming, and the grade placement system employed in Queensland, Australia. Now there are many differences between these two systems apart from the factor of homogeneous grouping which may have influenced the results obtained, not least among which is the fact that, because of our examination system and indeed for other reasons, teachers in this country are motivated to extend every child to the limits of his ability, whereas in countries employing the grade system, such as Australia, the class teacher's main objective is to get *all* children over a common hurdle—the syllabus for the grade. This latter system must necessarily result in greater homogeneity but whether it results in an overall raising of attainment levels can only be determined from empirical investigations. However, it is important to note that comparisons of this kind will not produce evidence to show whether streaming or not streaming is the better practice within our present educational system.

Discussion and conclusions

It is clear from this review of the sparse research that has been devoted to the problem of streaming that it is possible neither to justify the criticisms that have been levelled against it, nor to prove that streaming is a desirable and effective form of organisation.

In discussing his investigation, Blandford reaches the same conclusion as that drawn by French. He stresses the need for controlled investigations of the " action " type. The weakness of Blandford's research—as he himself points out—is that it involved a comparison between large streamed schools, mainly to be found in urban areas, with small unstreamed schools which for the most part are in rural areas. For a just comparison it would clearly be necessary to compare schools of the same size, serving similar catchment areas in some of which the children were assigned to streams in the usual way whilst in others they were divided at random into groups of mixed ability. Such an investigation needs to be done on a sizeable scale in order that due allowance may be made for differences in the quality of teaching.

The conditions necessary for carrying out such an investigation may well exist in various parts of the country. If a sufficient number of authorities and schools are interested to co-operate in such an inquiry the Foundation's staff would be willing to organise it and to analyse and report the results.

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Abstracts:

SOCIOMETRIC ANALYSIS IN A RESIDENTIAL TRAINING COLLEGE

Ph.D. Thesis, University of London, 1958

by J. CORNWELL

The Research Problem

THE research problem was to construct, refine and validate a sociometric test for prediction of final performance as measured by total course results in a two-year, six-term residential training course for men teachers. Furthermore, to facilitate subsequent diagnostic and counselling procedures, prediction was needed at the beginning of the second term, and test results must not only show substantial correlation with the Criterion, but must also prove particularly indicative of the bottom quartile of Criterion performance, and discriminate significantly between the third and fourth quartiles.

A near sociometric test of slightly modified Moreno pattern with multiple criteria concomitantly applied was chosen as the predictor with which to experiment, because, though other forms of peer nomination had been used for prediction in similar situations, there seemed to be no previous example of the application of systematic long-term refinement procedures to Moreno type criteria as a basis for prediction of teaching success.

It will be useful at this stage to explain very briefly what is meant by a near sociometric test of Moreno pattern with multiple criteria. The essential features of this type of test are as follows. It usually requires the individual to choose (sometimes also to reject) other individuals from amongst the members of his group as associates for specific and clearly defined purposes. These purposes are called ' criteria '. They provide the basis for the process of choice. When it is actually intended to put the criteria into action in the immediate future, they are ' real ' criteria. When the purpose specified is hypothetical (' *If* you were asked to choose . . .'), with no subsequent action intended, the criteria are ' near '. The criteria used may involve individuals in choices for official work-time groupings or for informal leisure groupings. The former are termed ' sociotelic ', the latter ' psychetelic '. A test with multiple criteria, that is, one which requires the participants to choose associates for a number of quite separate purposes, usually includes both types. All criteria, whether near or real, sociotelic or psychetelic, should be strong criteria: that is to say, they should provide the choosers with adequate motivation for making genuine and spontaneous choices and should be relevant to the special function of the group concerned. The choices made provide the basis for the study and measurement of inter-personal relations between group members and for the analysis of group structure.

Underlying Hypotheses

Certain hypotheses underlay the use of a sociometric test as the predictive measure. First, that since education was essentially a matter of inter-personal relations a student's

success as a teacher, and correspondingly his success in a course of teacher training, would be related to his effectiveness in inter-personal relations. Secondly, that a student's effectiveness in inter-personal relations with his peers in a residential community would be prognostic of his effectiveness in inter-personal relations with children. Thirdly, that the most appropriate techniques for measuring this effectiveness were sociometric, and that the data so obtained would provide a basis for prediction of success as valid as, or more valid than, non-sociometric techniques already in use. Fourthly, that peer ratings sociometrically derived would provide early in the course prognostic data as valid as that derived later in the course from the ratings of superiors, and would therefore be especially valuable for early diagnosis.

Degree of Randomisation

The research involved the construction, refinement and validation of the sociometric test, but not its standardisation. Therefore, little degree of randomisation can be claimed for the results. The 250 students concerned belonged to three consecutive year groups (of 94, 83 and 73 respectively) from the same training college for men teachers and probably provided a fairly representative sample of students attending this college in the present decade. It cannot be claimed, even though it may be considered very probable, that they are representative of male training college students in general, still less of all training college students, since the majority of these are women. Further, the external Criterion used was specific to a particular University Institute of Education. It is true that the examination schedules of other Institutes are fairly similar. Nevertheless, the conclusions from the present research cannot validly be generalised beyond the context in which they were evolved.

Experimental Procedure

The first step in the experimental procedure was the construction of an over-size sociometric test consisting of five sub-tests, each sub-test containing four criteria, making twenty criteria in all. From this over-size version it was hoped by experiment to produce a refined version of about one-third the length.

Individual sub-tests differed in aspect of orientation to the composite Criterion of total course performance. Thus, the first sub-test contained criteria designed to orient choices towards individuals possessing leadership qualities of the kind one associates with successful headmastership, whereas the second was oriented more specifically towards teaching skill. The third was designed to attract choices towards the intellectually able, the fourth towards those attractive as leisure-time companions and the fifth towards those desirable as co-workers.

Though the criteria comprising each sub-test had a common aspect of orientation to the Criterion they used different choice situations. In this way the sociometric test was designed to probe in a variety of choice situations any orientation of sociometric status likely to be significantly related to the Criterion.

Thereafter, the aim of the main experimental design may be summarised as progressively to step back the prediction time base from the sixth term to the second term of the

two-year course, at the same time systematically refining the sociometric instrument, in the hope that loss of predictive efficiency caused by lengthening of the prediction-Criterion interval on the one hand and lessening of degree of acquaintance on the other, would be offset by an increase in efficiency resulting from systematic refinement of the test.

Techniques of Analysis

The test was refined through three test versions, being reduced from twenty criteria to six criteria in the process. Each student year group was tested twice and Criterion performance was predicted from sociometric data obtained in every term except the first. Comparisons of predictive efficiency were made not only between earlier and refined test versions but also between near (hypothetical) and real (to be acted upon) data, positive (acceptance) and negative (rejection) data, and weighted and unweighted choices (i.e. between scoring which took account of level of choice preference and scoring which ignored it). A study was also made of the attitudes of students to requests for negative sociometric choices, and near and real criteria were compared in this respect.

In addition to rank order correlations with Criterion performance, the predictive efficiency of each test version was further investigated for capacity to discriminate between the third and fourth quartiles of performance. The Mann-Whitney U Test was chosen for this purpose as the non-parametric statistical technique most appropriate here for investigating the significance of the difference between two independent samples. Another non-parametric test, the Wilcoxon Matched-Pairs Signed Ranks Test, was frequently used to test the significance of differences in bottom Criterion quartile performances on test versions undergoing comparisons when two related samples were involved.

In item (i.e. criterion) analysis the phi coefficient was used for assessing the validity of different criteria by comparing the scores on each criterion of the top and bottom quartiles of the Criterion performance distribution. Chi square was used for the test of the null hypothesis and establishment of the significance of phi coefficients.

In addition to this consideration of their predictive efficiencies, criteria were also scrutinised in respect of volume and diffusion of sociometric response elicited, the former as indicative of their relative strength and attractiveness to the choosers, the latter as indicative of the degree to which they caused choices to be spread over a range of different individuals. As a result of this three-fold analysis six criteria were eventually selected for retention in the final test version. Finally, a comparison was made between the sociometric predictor and some available non-sociometric predictors, namely, an intelligence test, academic examinations and tutors' ratings.

Final Test Version

Instructions

Consider separately and carefully each item below, and for each one write down:

(*a*) the names of not more than five students of your year *most* acceptable to you in the role described;

(*b*) the names of not more than five students of your year *least* acceptable to you in the role described;

If you do not wish to nominate as many as five students for a particular role you may nominate less than five. You are, of course, permitted to nominate any student for more than one role, if you wish. Be responsible and deliberate in your choices. Do not nominate yourself!

1. As a member of your teaching staff if you were a Headmaster.

   (*a*) .....

   (*b*) .....

2. As a College Representative in an inter-college Brains' Trust.

   (*a*) .....

   (*b*) .....

3. As your partner in a group engaged in an investigation.

   (*a*) .....

   (*b*) .....

4. As a teacher of a class containing a child of yours.

   (*a*) .....

   (*b*) .....

5. As one of the ' Best Read ' students in College.

   (*a*) .....

   (*b*) .....

6. To share with you the responsibility for a School Camp.

   (*a*) .....

   (*b*) .....

(NOTE : For the purposes of research, negative choices in the form of nominations of individuals *least* acceptable to the chooser were asked for in the test version above. However, positive choices alone were found to provide a significantly better basis for prediction than positive and negative choices combined. Negative choices provided additional data of diagnostic value, but whether this balances the resentment sometimes caused by asking for them is doubtful.)

Summary of Conclusions

The main conclusions of the research may be summarised as follows:

1. A near sociometric test with concomitant multiple criteria was constructed, refined and validated to give a rank order coefficient of correlation of $.67 \pm .064$ between positive sociometric status and a total course results Criterion.
2. The sociometric test discriminated significantly between the third and fourth quartiles of performance. The third and fourth sociometric quartiles showed significantly different Criterion performance. The third and fourth Criterion quartiles showed significantly different sociometric performance. Fourteen out of twenty-one students in the bottom quartile of sociometric ranks appeared in the bottom quartile of Criterion ranks. Of the remaining seven, four appeared in the lower half of the third quartile of Criterion ranks.
3. This prognosis from sociometric data was made at the beginning of the second term of a two-year, six-term training college course for men teachers. The prediction-Criterion interval was seventeen months, thus leaving adequate time for diagnostic and counselling procedures.
4. In the specific context of this research a significantly better basis for prediction was provided by:
   (*a*) near sociometric choice than the feasible real sociometric choice;
   (*b*) positive sociometric choice than positive and negative choice combined;
   (*c*) sociotelic criteria than psychetelic criteria;
   (*d*) weighted choices than unweighted choices.
5. In a comparison with non-sociometric predictors the sociometric test gave a higher correlation (rank, $.67 \pm .064$) with the Criterion of total results than either intelligence test scores (Pearson, $.07 \pm .104$) or examination results (Pearson, $.54 \pm .078$) obtained at approximately the same point in the course. It also gave a higher correlation than either of these with final teaching mark (rank, $.57 \pm .78$ as compared with $.06 \pm .105$ and $.35 \pm .097$ respectively, both Pearson).
6. At a point four months earlier in the course it gave as high a correlation (rank, $.57 \pm .078$) with final teaching mark as that obtained from first-year assessments of teaching ability by tutors (Pearson, $.56 \pm .076$).
7. A composite predictor obtained by combining sociometric data and examination results gave a correlation (Pearson) of $.73 \pm .052$ with the Criterion of total course results, the prediction being made at the beginning of the second term in the first year of the course.
8. A composite predictor, obtained by combining sociometric data, examination results and first-year ratings of teaching ability, gave a correlation of $.75 \pm .048$ with the Criterion of total results. This combination of data was not available until towards the end of the third term in the first year of the course.
9. A composite predictor obtained by combining sociometric data and first-year ratings of teaching ability gave a correlation (Pearson) of $.645 \pm .064$ with final teaching mark.

Comment

Apart from its utility as a separate measure, the sociometric test would seem to provide a valuable supplement to existing non-sociometric predictors. Its combination with the early examination results to give a composite predictor with a correlation of .73 with the Criterion, available as early as the beginning of the second term in the six-term course, would seem to be particularly useful for the early recognition of students likely to have difficulty in passing the course, especially as the sociometric test has been shown to be discriminating at the bottom quartile of Criterion performance. Moreover, the sociometric data are not of predictive value only, but of diagnostic also. Student difficulties are not likely to be ones of scholarship or technique alone. They are likely to consist also of problems of orientation and personal adjustment. By revealing the social atoms of the individuals concerned (i.e. the network of incoming and outgoing choices linking them with other individuals) and permitting analysis of the relevant facets of group structure, the sociometric test provides the tutor with the means of added insight into the interpersonal relations of the individuals concerned, and puts him in a better position to help them.

The imminence of the three-year course in training colleges would seem to give added significance to these results. On the one hand it increases the urgency of early diagnosis of probable failures, since there will be even more at stake in failure. On the other hand it gives adequate time for counselling procedures to operate once a reliable diagnostic basis has been secured.

THE EDUCATION OF DEAF CHILDREN SUFFERING FROM CEREBRAL PALSY

M. Ed. Thesis, Department of Education of the Deaf, University of Manchester

by GERARD CONNOLLY

Purpose of the Research

THE purpose of the enquiry was to make an intensive study of five children, who were both deaf and cerebral palsied, and set this against a background study of the hearing capacity of 262 cerebral palsied children.

Nature of Problem

The nature of the problem of cerebral palsy allied with deafness is presented, together with information regarding historical background, both educational and medical. Details are given of various bodies, institutions, schools, hospitals, etc., caring for the cerebral palsied.

Testing of Hearing Loss

262 cerebral palsied children were tested for hearing loss by pure tone audiometer. The frequencies used were 500, 1,000, 2,000 and 4,000 cycles per second, with a test at 250 if there was no response at 500. To ensure accuracy a re-check was taken at 1,000 in either ear. The mean hearing loss over the frequency range important for speech, 500-2,000 cycles per second, was calculated. No activities were used with the test, since such activities, although valuable for use with children who are not cerebral palsied, prove a great source of distraction with those so handicapped.

From the scores of this testing, the following tables were drawn up.

MEAN HEARING LOSS AMONG 262 CEREBRAL PALSIED CHILDREN OVER THE FREQUENCY RANGE 500-2,000

	15-34 dbls.		35+ dbls.		
	One ear	*Both ears*	*One ear*	*Both ears*	*Total*
Cases	28	11	11	8	58
Percentage ..	10.7	4.2	4.2	3.1	22.2

DISTRIBUTION OF HEARING LOSS AMONG 215 SPASTIC CASES

	15-34 dbls.		35+ dbls.		
	One ear	*Both ears*	*One ear*	*Both ears*	*Total*
Cases	25	8	8	6	47
Percentage ..	11.6	3.7	3.7	2.8	21.8

Distribution of Hearing Loss Among 28 Athetoid Cases

	15-34 dbls.		35+ dbls.		
	One ear	*Both ears*	*One ear*	*Both ears*	*Total*
Cases	1	—	2	1	4
Percentage ..	3.6	—	7.1	3.6	14.3

Distribution of Hearing Loss Among 19 Ataxic Cases

	15-34 dbls.		35+ dbls.		
	One ear	*Both ears*	*One ear*	*Both ears*	*Total*
Cases	2	3	1	1	7
Percentage ..	10.5	15.8	5.3	5.3	36.9

Average Hearing Loss (Both Ears) in Decibels at 4,000 Cycles

Spastic	*Athetoid*	*Ataxic*
215 *cases*	28 *cases*	19 *cases*
13	24.1	22.3

Results of Hearing Tests

There is a considerable incidence of hearing loss among cerebral palsied children, more so than among children not cerebral palsied. Anong cerebral palsied children 3.1 per hundred show hearing loss of one kind or another, while with children not cerebral palsied the incidence is 0.1 and upwards per hundred for partially deaf and 0.1 per hundred for deaf. A greater incidence of high tone loss was found among the athetoids and ataxics.

Distribution of Cases

The 262 cases were analysed for distribution according to:

Area. Comparison between Areas. The majority of cases were from Lancashire but a comparison of figures from other parts of the country relating to various aspects of cerebral palsy show that the sample of 262 cases can be regarded as typical.

Parental Occupation. It was found that cerebral palsied children can be considered to belong peculiarly to no particular group of society.

Causes of Cerebral Palsy. From 74 cases, showing 15 causes of cerebral palsy, the highest incidences were in Premature Labour (19%), Prolonged Labour (15%), Use of Instruments (13%), Jaundice (10%) and Meningitis (8%).

Deafness in Relation to Causes of Cerebral Palsy. There is a considerable increase in the number of cases of defective hearing where factors of stress and strain have been present at the birth.

Extent of Involvement of Limbs. From 215 cases where the cerebral palsy handicap was that of spasticity it was found that 54% were hemiplegias, 40% were quadriplegias, 5% were paraplegias and 1% were monoplegias.

Laterality. There is little difference in laterality in hemiplegias both within and between the sexes.

Age at Onset. In a sample of 109 cases it is shown that 95% occurred during the first two years of life. No onset is shown after the eighth year.

Age when admitted to school. In a sample of 198 cases it is shown that the children were admitted to school at a reasonably early age, 37% entering by the age of five years and 81% by the age of eight.

Five Deaf Palsied Children

The five deaf cerebral palsied children were given the Terman-Merrill Intelligence Test, adapted by the use of larger material to facilitate handling and by the use of mime or gesture to convey the requirements of the test. No help was given with language when such language was an essential part of the test. The results of the test are presented as a " Mental Age," such a term being used in the sense of a measure of the child's degree or extent of educability.

RESULTS OF TERMAN-MERRILL INTELLIGENCE TESTS WITH FIVE DEAF CEREBRAL PALSIED CHILDREN OVER A PERIOD OF FIVE YEARS

Child	*Chron. age at first test*	*Mental age at* 1st test	2nd test	3rd test	4th test	5th test	6th test	*Chron. age at last test*
R.H.	11.6	4.1	5.3	5.8	6.7	6.7	7.2	16.7
D.B.	10.0	5.6	5.8	7.0	7.9	8.0	Left	14.7
H.S.	12.7	6.0	6.0	7.6	8.6	Left	—	16.0
S.L.	10.0	5.3	5.8	6.8	7.9	7.9	8.2	15.1
J.C.	7.8	2.0	2.0	2.0	3.0	3.3	5.5	12.8

Motor Development

The five children were evaluated for improvement in walking and balance and for improvement of skill in fine manipulative ability as at the beginning and the end of the research. The scales used were devised by the author and given at yearly intervals without previous practice, so that they should be measures of all-round motor development.

All five children had, at one time or another, some treatment by physio- and occupational therapy, but this amounted to no more than two hours a week for each child, and in no case did it extend through the whole of the period of research.

TEST OF GROSS MOTOR SKILLS

Walking a line 10 ft. long. Number of faults (foot off line, overbalance, etc.)

Child	*1st test*	*2nd test*	*3rd test*	*4th test*	*5th test*	*6th test*
R.H.	5	4	2	2	2	1
D.B.	1	0	0	0	0	Left school
H.S.	1	2	1	0	Left school	
S.L.	3	2	1	1	1	1
J.C.	3	3	2	2	1	1

TEST OF FINE MOTOR SKILLS

Peg board with twenty-five ¾in. diameter pegs.
Placing pegs in board, using dominant hand. Time taken in seconds.

Child	*1st test*	*2nd test*	*3rd test*	*4th test*	*5th test*	*6th test*
R.H.	360	210	240	150	140	140
D.B.	195	180	150	135	120	Left school
H.S.	60	50	43	40	Left school	
S.L.	90	70	70	65	60	50
J.C.	100	90	90	70	55	55

Speech

Ability to lip-read and ability to talk were also assessed. In this four showed considerable improvement and even the fifth had made some progress.

Educational Development

The Schonell standardised tests in Silent Reading, Graded Reading and Mechanical Arithmetic were given at the beginning and at the end of the research. No practice on the tests was given at any time. Three children showed an improvement at the end of the research. The other two, although still not scoring on the retest, had developed some ability in the subjects.

STANDARDISED TESTS OF EDUCATIONAL ATTAINMENTS

Child	*Chron. age*	*Silent Reading* — *Attainment age*	*Graded Reading* — *Attainment age*	*Mechanical Arithmetic* — *Attainment age*
R.H. ..	10.4	No score	No score	No score
	16.9	No score	No score	No score
D.B. ..	9.0	No score	6.0	7.9
	14.7	8.5	8.10	11.9
H.S. ..	11.5	No score	5.4	7.0
	16.0	7.9	6.11	8.5
S.L. ..	8.10	No score	5.2	No score
	15.3	6.10	7.1	7.9
J.C. ..	6.6	No score	No score	No score
	12.11	No score	No score	No score

In other educational attainments, as found in an ordinary school curriculum, all five children showed progress in varying degree.

SUBJECTIVE EVALUATION OF OTHER EDUCATIONAL ATTAINMENTS

Child	R.H.	D.B.	H.S.	S.L.	J.C.	
Composition	—	30	20	20	—	Beginning.
	10	60	40	30	—	End of research.
Writing	—	40	50	30	20	
	—	70	80	60	60	
Drawing	—	30	40	20	20	
	20	60	80	50	50	
Handwork	10	30	40	40	30	
	40	60	80	60	50	
Physical Education ..	—	30	10	10	—	
	20	60	40	50	20	
Games	—	20	10	—	—	
	20	60	50	50	10	
Dancing	—	30	—	10	—	
	10	50	40	40	10	
Nature Study	—	10	10	10	—	
	20	60	70	50	—	
Gardening	—	30	20	20	—	
	30	50	40	50	30	

Figures given as percentages, 100 per cent. being the score of the performance of a normal child of equivalent age.

Emotional Development

It was found that the two children who had become deaf and cerebral palsied at a later age manifested behaviour difficulties not found in the three handicapped from birth or early infancy.

Vocational Capabilities

One child found suitable employment at the end of the period and two could be considered to be capable of earning a living. The remaining two children presented certain difficulties, the one on account of severe athetosis affecting all four limbs, and the other (a hemiplegic spastic) chiefly because of a certain degree of maladjustment and concomitant epilepsy.

Conclusions

Deaf children who are cerebral palsied should be taught by qualified teachers of the deaf, in a school for the cerebral palsied where all facilities for physio- and occupational therapy are available. In view of the great complexity of handicap it is suggested that a class of deaf cerebral palsied children should consist of not more than six pupils.

Bibliography

A bibliography is given, covering works both in this country and the United States, together with a list of further pertinent literature.

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